DOCUMENT RESUME

ED 285 728 SE 048 316

TITLE	Investigating Our Environment. Science: Grade 6.
INSTITUTION	New York City Board of Education, Brooklyn, N.Y. Bureau of Curriculum Development.
PUB DATE	[87]
NOTE	256p.
AVAILABLE FROM	New York City Board of Education, Division of Curriculum & Instruction, 131 Livingston Street, Room 613, Brooklyn, NY 11201 ($8.00).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Ecological Factors; *Ecology; *Elementary School Science; Energy Education; *Environmental Education; Experiential Learning; Field Trips; Intermediate Grades; *Pollution; *Science Activities; Science and Society; Science Curriculum; Science Education; Science Experiments; *Science Instruction
IDENTIFIERS	*New York City Board of Education

ABSTRACT

Intended mainly for use in the intermediate grades, this document provides demonstrations, field trips and laboratory experiences designed to help students investigate the role that people play in problems associated with environmental quality, pollution, and ecology in general. The book was developed as an alternative program to the regular sixth grade curriculum guide in science in the New York City school system. The guide is made up of activities which have been categorized in several ways. Section I, "Living Things and the Environment," contains activities that encourage students to become more aware of the various environments of which they are a part, and deals with the effects of climate on those environments. Section II, "Interactions in the Environment," includes activities about interrelationships of living things, hosts and parasites, and ecosystems. Section III, "Energy in the Environment," relates to the sun's energy, other energy forms, and forces that change the environment. The last section, "Man Changes the Environment," focuses on air pollution, water pollution, human population growth, food, forests, endangered species, conservation, and community environmental improvement. (TW)

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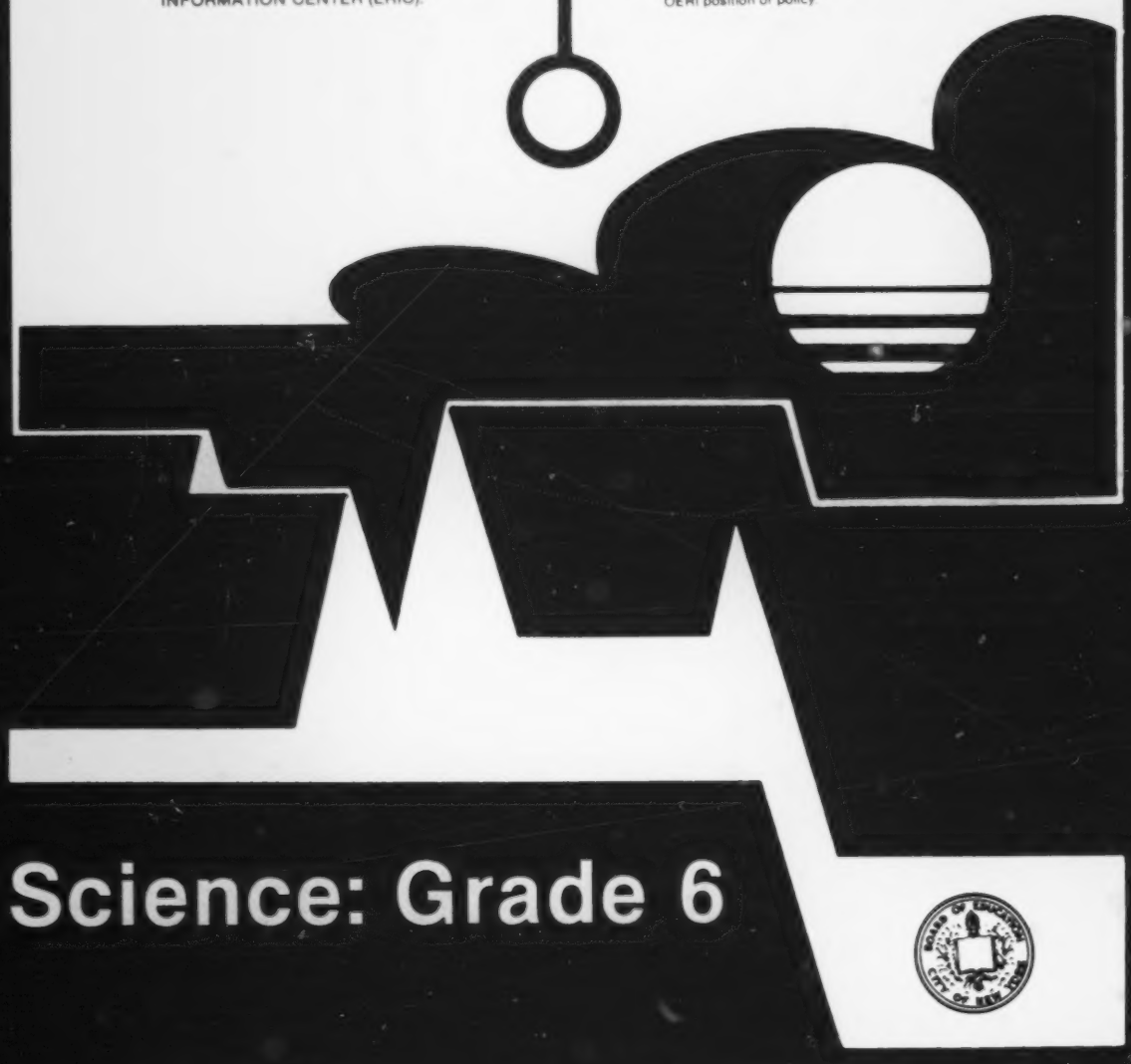

Science: Grade 6

SE 018 316

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INTRODUCTION

Investigating Our Environment, Science: Grade 6 is a program developed to serve as an alternative to Science: Grade 6. Intended basically for intermediate school use, the material provides appropriate demonstrations, field trips and laboratory experiences through which students can investigate the role of people in relation to problems of ecology and environmental pollution and controls.

Activities should be conducted in an open-ended manner to allow for diversions, extensions and deletions that can lead to greater learning dividends. The period of time to allocate to each problem should be based on students' interest in it and on their technical ability to cope with it. For general discussion of science learning at the grade 6 level consult the introductory section (pages 1-20) of Science: Grade 6.

It is expected that the investigations in this guide will lead young people to an increased awareness of the problems that threaten human survival and equip them with the basic understandings and skills to enable them to participate effectively in efforts to alleviate and solve these problems.

ACKNOWLEDGMENTS

This publication, Investigating Our Environment, Science: Grade 6, represents the combined efforts of the Bureau of Science, Harry Milgrom, Director; and the Bureau of Curriculum Development, Leonard Simon, Assistant Director (Acting).

Harry Milgrom initiated the environmental adaptation of the grade 6 program and provided overall direction in the development of this guide.

The members of Grade 6 Science Advisory Committee who assisted in the planning and design of the quide were:

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Alan Winkler, Teacher of Science----------JHS. 278K
Stanley Wolfe, Assistant Principal Supervisor of Science-------I.S. 88K

This Committee prepared the first draft outline of the Environmental Science Program which was the basis for a pilot study in 15 intermediate schools.

Feedback reactions and suggestions from the supervisors and teachers in the pilot study were of great value in the preparation of this publication.

The members of the writing committee were:

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A special thanks is expressed to Dr. Dorothy Silverman, Bureau of Curriculum Development, for her assistance in expediting the work of the writing committee and the preparation of this guide.

Grateful acknowledgment is expressed to the many teachers and supervisors who volunteered to serve as pilot feedback sources in translating the outline into actual lessons and activities. Their participation helped insure the creation of a provocative and stimulating course of study suitable for grade 6 pupils.

The schools involved in the pilot program were:

I.S. 10M	I.S. 88K	I.S. 292K
I.S. 70M	I.S. 303K	I.S. 61Q
P.S. 158M	I.S. 223K	P.S. - I.S. 91Q
I.S. 144X	I.S. 227K	I.S. 142Q
I.S. 61K	I.S. 275K	I.S. 61R

Cover by Kathleen Asvestas

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I. LIVING THINGS AND THE ENVIRONMENT

A. FINDING OUT ABOUT THE ENVIRONMENT

1. WHAT IS AN ENVIRONMENT?

Outcomes:

. The environment is composed of all the living and non-living things that surround an organism.

. The environment may change with place and time.

Motivation:

Take the class on a short walk around the school neighborhood. Tell them to list everything they can observe, using all their senses. Ask them to be aware of sounds, odors, color and appearance.

Development:

1. Tabulate pupils' observations on the chalk board. Point out that some things they observed are living and some are non-living. Identify the living things as an organism. Help the pupils classify the organisms they observed on their walk (plants, animals.)

2. Write the word environment on the board. Guide the pupils to realize that all their observations listed on the board describe an environment. Elicit from the pupils that the environment consists of all the living and non-living things that surround an organism.

3. Divide the class into small groups. Give each group a different scene. (seashore, skin divers, underwater, mountain village, city street, jungle, astronauts on the moon, miners in a cave.) Have the pupils in each group work together to describe their environment. Allow 10 minutes and then have each group show their pictures and describe their environment. Have the class compare environments. Elicit that environments may have some similar things and many different things.

4. Provoke class discussion by asking, "Is New York City the same today as it was when the Pilgrims came here?" (Refer to social studies texts for pictures.)

5. Ask, "What causes environments to differ?" Use each groups observations to show that location causes these differences. (The location of a tiger's environment makes it different from a skin diver's environment.) Time also plays a role in causing changes in the environment.

Summary:

1. What is an environment?

2. Describe the environment of the following:

   a. an Eskimo

   b. A subway motorman

   c. A cowboy

   d. An ant

3. Why do environments differ?

Homework:

1. Draw or get a picture of a fish in its environment. Describe as much of its environment as you can.

2. Draw or get a picture of any other animal. Describe the factors in the environment that you observe.

Materials:

A set of 9x10 large pictures of different environments.

2. WHAT MAKES AN ENVIRONMENT?

Outcomes:

- Light, water, air, temperature and the earth's surfaces are some physical factors of an environment.
- The environment at any one location can change from time to time.
- Environmental changes may be sudden or gradual.

Motivation:

Ask the pupils to assist you in planning to set up an aquarium. Elicit things you would need to set up the aquarium tank. Encourage pupils who have raised tropical fish to explain what they did.

Development:

1. Set up an aquarium, if possible, using materials suggested by the pupils. (Tank, gravel, water, plants, air pump, filter, light.) Have class describe the environmental conditions of a fish and list all items on the board. Elicit that light, water, air and temperature are some physical factors of the environment. Fish, plants and other living things are the biological factors of the environment.
2. Show the class a picture of a winter scene. Ask them to identify some of the physical factors of the environment. Show the class the same scene at another season. Have them compare both environments. Elicit that the environment of one location can change from time to time because of the weather.
3. Use a picture of a volcano to illustrate that some changes in the environment are sudden. Ask pupils to give other examples of sudden changes (flash floods, earthquakes.) Have pupils identify what factors in the environment have been changed (land has been washed away, lava covers the ground or a mountain has been built up).
4. Without going into great detail ask the pupils to explain how automobile exhaust fumes in the air affect the environment. Guide the pupils to understand that the air changes because of the fumes and that this is a gradual change in the environment. Ask for other gradual changes that occur in the environment. Examples may include the wearing away of soil by running water, the rusting of metal or cracking of roads. Tell the class that a change in the earth's surface is another physical factor which describes the environment.

Summary:

1. Describe the environment of the classroom.
2. What factors were used to describe the environment?
3. How does an open window change the environment of the classroom?
4. What are some factors of an environment that change from daytime to night time?
5. Why is it important to study an environment over a long period of time?
6. Give examples of sudden environmental changes and gradual environmental changes.

Homework:

1. What kind of environment does a newly planted seed need to grow?
2. List several ways your environment changes over the year.
3. Visit an aquarium pet store. Describe how the tanks are set up. Why are pumps and filters used?

Materials:

1. 10 gal. fish tanks
2. aquarium gravel
3. filter and air pump
4. plants
5. light
6. large pictures
7. small fish

3. WHAT IS THE STUDY OF ECOLOGY?

Outcomes:

- The relationships of living things to their environments may be beneficial or harmful.
- Ecology is the study of relationships of living things to their environment.

Motivation:

Draw a 36 inch circle on the floor with chalk. Ask 3 pupils to take off their shoes and step into the circle holding their shoes. Tell the pupils to put their shoes back on while standing in the circle. Have class observe how long it takes. Do the same with 7 pupils inside the circle. Ask why the second group had so much trouble performing such a task.

Development:

1. Refer to the previous discussion of setting up of a fish aquarium. "How many fish can be placed in the same tank?" What would happen if we put large and small fish together?" Fish compete for space, food and air. "In nature, how is overpopulation prevented?" "How does this benefit the survival of the other fish?"

2. Call attention to the fact that the water was left standing overnight. Indicate to the pupils that chemicals are added to drinking water to help make the water safer for us. However, the chemicals may be harmful to small fish. Elicit that an environment may be helpful to one living thing but harmful to others. Explain that letting the water stand for a day helps get rid of some chemicals from the water. Letting the water stand also helps moderate its temperature.

3. Add fish to the aquarium. Write on the board, our fish will live if... Have the pupils list factors in that environment which help the fish. They should include, the right temperature, enough food, light, oxygen, clean water, not too many fish, no harmful chemicals. Guide the pupils to understand that in order to keep their fish alive and healthy they must study how the environment affects the fish. Define ecology as the study of how living things react with each other and with their environment.

4. The interrelationships stressed in this lesson may readily be demonstrated by involving the pupils in the following experience:

   - At least one week in advance plant 10 radish seeds in each of six small containers.

- Provide a set of six containers for each class involved so that they may compare their results against those of the other classes.

- Label each container with specific information relating to the conditions and variables as shown in the table.

- Provide time at the beginning of the class lesson for pupils to make direct observations (plant-leaf vigor, color, firmness) and measurements (plant size, number of leaves, leaf size).

Plant Number	Water	Light or dark	Thinned Out	Chemical Herbicide	Soil Quality
1(control)	regular	light	yes	no	humus
2	minimal	light	yes	no	humus
3	regular	dark	yes	no	humus
4	regular	light	no	no	humus
5	regular	light	yes	yes	humus
6	regular	light	yes	no	sandy soil

Summary:

1. What is ecology?

2. Copy the following "To survive, the fish should have:" (List all necessary conditions.)

3. What conditions must be avoided?

4. Make the same lists for humans and trees

Homework:

1. What does the word terrarium mean?

2. Where would you look to find the answer?

3. Where would you look to find out what things you could put in a terrarium?

4. List some things you would put in a terrarium.

5. Bring in materials to be used to set up a terrarium.

Materials:

1. small fish
2. radish seeds
3. soil or vermiculite
4. small containers (flower pots)
5. plant herbicide (can be purchased in garden or nursery stores)
6. sandy soil

B. PERCEIVING THE ENVIRONMENT

4. HOW DO WE STUDY THE ENVIRONMENT?

LABORATORY LESSON

Outcomes:

. Man learns about his environment through his senses.

. Our senses include sight, hearing, smell, touch and taste.

Motivation:

Place a ball into your desk drawer before the class arrives. Challenge the class to describe the object placed inside of your desk drawer.

Development:

1. Using the motivation elicit from the pupils that you must use your senses to identify an object or any part of the environment.

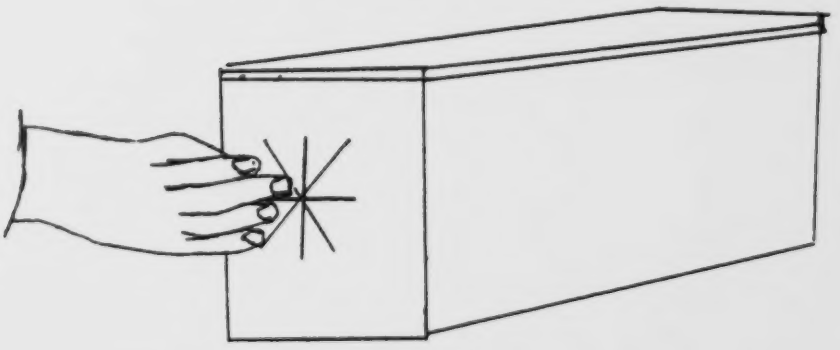
2. Show the class the object and ask them to describe it. List the description on the board. Ask a pupil to name the object. Point out the difference between describing an object and naming it.

3. Make a set of 4 observing boxes. (3 boxes may be made from shoe boxes, the 4th should be larger.) Assemble the boxes as follows:

   Box #1 - Place 4 or 5 objects such as rocks, metal coins, keys inside. Cover the top of the box with plastic wrap.

   Box #2 - Place 4 or 5 objects such as rock, sponge, rubber ball, nail, clip inside. Seal the cover with tape. Leave the contents loose in the box.

   Box #3 - Use a larger box. Cut holes large enough for pupils to put hands through opening to feel objects inside. Place some plastic sandwich bags inside. Fill each bag with flour, sand, beads etc.



Box #4 - Make several holes in the top of box. Place a cut lemon, garlic or cotton soaked in ammonia. You may use more than one box.

Station #5 - Pour some salt water, lemon juice, or sugar water into a beaker. Instruct pupil to place his finger in the liquid and then place the finger to his tongue. Have him rinse his mouth with fresh water. Call attention to the danger of tasting unknown chemicals.

4. Place a box at each desk. Allow pupils to spend 3 minutes at each box or station. Groups of 2 pupils are ideal. At a given signal allow them to move to the next station.

Homework:

1. Where am I? The day is hot and very dry, the ground is brown and black, it is cracked with pebbles and sand particles. Nearby is a green object. It has stickers all over its surface. The stickers are coming out of a rubbery and thick plant.

2. Where am I? All around we are tall brown objects with green objects attached to them. These objects block out the light from the sun. Some green objects have fallen to the ground and have turned brown. The ground is damp and cool.

Materials:

1. 3 shoeboxes
2. 1 larger box
3. tacks, clips, rocks, keys
4. plastic wrap
5. rubber ball
6. sponge
7. sandwich bags
8. flour, beads, sand
9. object with distinctive odor
10. beaker
11. clear solution with distinctive taste

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON 4

Problem:

How can we study the environment?

Introduction:

As you examine some objects, you will make observations. You will describe them. Observation making is one of the most important activities in science. After doing this exercise you will learn how to make and write down observations.

Materials:

1. Boxes located at different desks called stations.

2. Objects which you will describe.

Procedure:

1. Follow the directions on each box at each station.

2. Spend about 3 minutes at each of the five stations.

Station No. 1: DO NOT TOUCH THIS BOX.

Look at the objects inside the box.
Observe and describe as many of these objects as you can.

Station No. 2: DO NOT TAKE THE TOP OFF OF THIS BOX

You may lift, gently shake, or tip this box to observe and describe the objects inside this box.

Station No. 3: DO NOT LIFT THIS BOX
DO NOT TAKE THE TOP OFF
DO NOT LOOK INSIDE

Put your hands through the openings at the sides.
Use your hands to describe the objects in the box.

Station No. 4: DO NOT TOUCH THIS BOX

Place your nose near some of the openings in the top. Use your nose to describe the object inside.

Station No. 5: Place your finger into the liquid in the beaker. Touch your finger to your tongue. Describe the solution.
Rinse your mouth afterwards. It is dangerous to taste unknown chemicals.

Observations:

Description of objects at Station No. 1: _____

_____

_____

Description of objects at Station No. 2: _____

_____

_____

Description of objects at Station No. 3: _____

_____

_____

Description of object at Station No. 4: _____

Description of object at Station No. 5: _____

Conclusion:

1. How did you make your observations?
2. List the senses used at each station.
3. Name the objects described at each station.

5. HOW DO OUR EYES GIVE US INFORMATION?

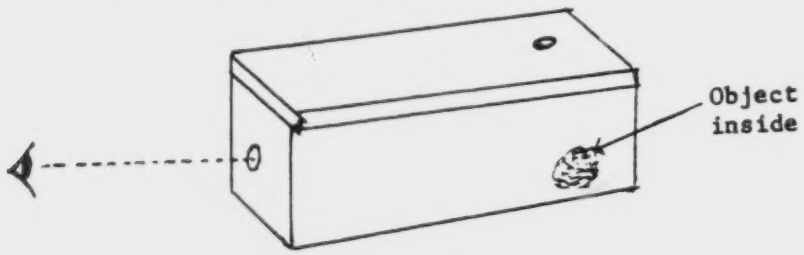
Outcomes:

. We see objects when light from these objects enter the eye.

. Parts of the eye are sensitive to light.

Motivation:

Place a small hole in the cover of a shoe box and a peep hole at the side of the other end of the box. Have an object (ball, crayon, pen) placed securely under the opening in the lid. Cover the opening on the top with your finger and challenge the pupils to look through the peep hole and identify the object. Then uncover the hole in the top.



Development:

1. Elicit from the pupils that they could see the object only when light hit it. Explain that we see objects when light reflects from these objects to our eyes.

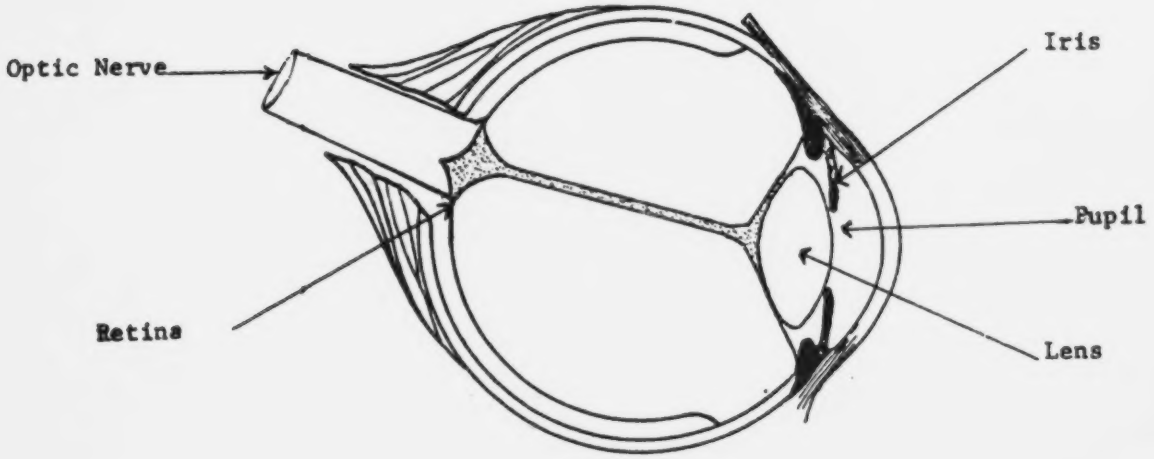
2. Lead the discussion to pupils' experience in taking pictures with a camera. Ask the pupils to suggest what things affect the quality of the pictures. Elicit that film is sensitive to light and must have enough light to form a good picture.

   The eye is also sensitive to light. Use the analogy of the camera to develop understanding of how the eyes see light.

   The amount of light that enters the eye is controlled by the iris which opens or closes to allow more or less light into the eye.

3. Use a transparency or model to show the parts of the eye. Have the class draw a labeled diagram. Include the iris, pupil, lens, retina and optic nerve.

EYE



Briefly discuss the function of each: iris - regulates amount of light entering the eye

pupil - opening through which light passes lens - focuses light

retina - area sensitive to light on which a picture of what you see forms.

optic nerve - carries the message to the brain.

4. Suggest that pupils observe how the iris works. Working in pairs, have one pupil look into his partner's eyes. The other partner will close and cover his eyes. After one minute have him open his eyes. The other partner should observe how the iris closes the pupil in the center of each eye.

Summary:

1. If we can't see without light, explain how it is possible to see our hands at night in the "dark."

2. Draw a labeled diagram of the eye.

3. Name the parts of the eye and list the function of each.

Homework:

1. What happens to the pupils of our eyes when we walk into a darkened movie?

2. What happens to the pupils of our eyes when we walk out of a darkened movie into strong sunlight?

3. Explain how a camera is like our eyes.

Materials:

1. Shoebox
2. Coin, key, or ball
3. Transparency or model of eye.

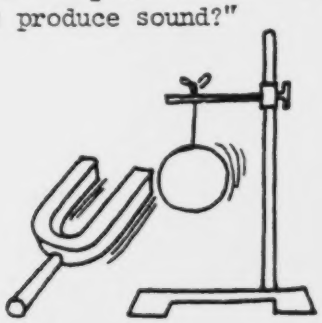
6. HOW DOES THE EAR GIVE US INFORMATION?

Outcomes:

- Vibrating objects produce sound
- The structure of the ear enables us to hear
- The brain interprets signals from our sense organs

Motivation:

Strike a tuning fork and place the prongs into a beaker of water. Strike the tuning fork again and hold it near a ping pong ball which is suspended with a string from a stand. Ask, "When do objects produce sound?"



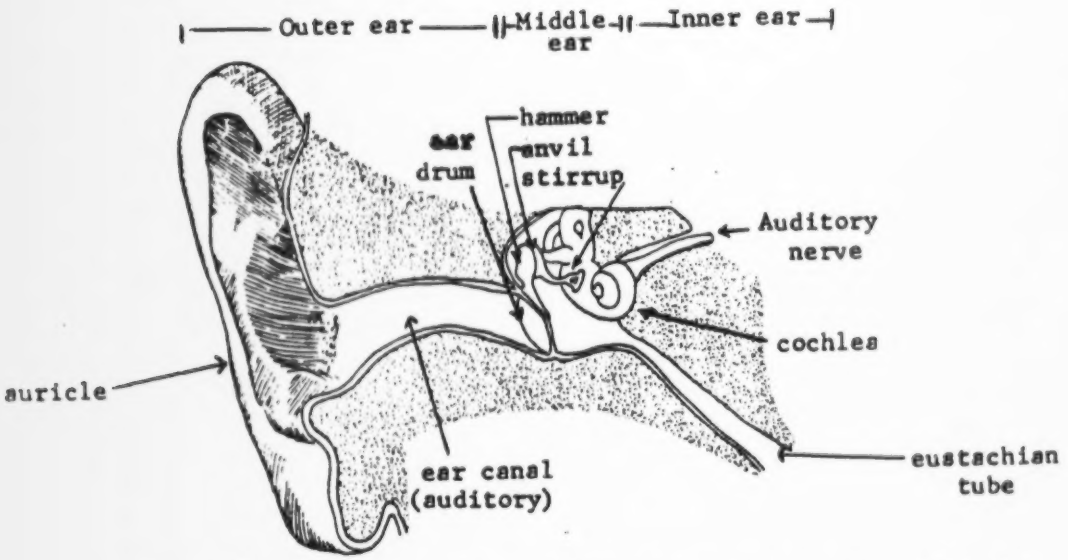
Development:

1. Instruct the class to place their hands on their voice box (Adam's apple) Then have them hum. As the sound is produced, how does the voice box feel? Refer back to motivation and elicit that sound is produced when an object vibrates.

2. Refer to the laboratory exercise using the shoeboxes. Review the various senses used to identify objects. Start a game. Without looking, have pupils identify the source of various sounds -(e.g. footsteps, breaking a pencil, opening a window, scissor cutting a piece of paper, clicking of a ballpoint pen.)
   Guide pupils to conclude that sound played an important role in interpreting the environment.

3. Use a model of the ear or transparency to discuss the parts of the ear.

   Distribute mimeograph copies of the ear structure. Identify the different parts and explain how they work.



Identify the auricle and ear canal of the outer ear. Tell the class that sound waves cause the ear drum, hammer, anvil and stirrup of the middle ear to vibrate. They carry the sound to the middle ear. The inner ear contains the liquid filled cochlea which carries the sound to the auditory nerve.

4. Compare the shape of the outer ear to a funnel. Have the pupils roll a piece of paper into a cone to demonstrate how the outer ear catches and gathers sound. Have them listen to sounds with this horn and without it.

5. Using pictures of various animals discuss the shape and size of their ears. Discuss how some animals are able to move their ears to catch sounds. (Examples: dog, elephant, bat, rabbit) Relate the ability to hear sound to the ability to hunt and to survive.

6. Hold up a whistle and ask pupils to describe it. Point out that senses of sight and sound help describe the object. Then ask a pupil to name the object. Ask, "Which part of your body helps us to name and identify objects. Guide the pupils to see that all information gathered by the senses goes to the brain. Draw attention to the fact that the brain interprets the signals from our sense organs.

Summary:

1. What causes sound?

2. What part of the body allows us to hear?

3. What is the function of the auricle and ear canal?

4. What happens when sound hits the ear drum, hammer, anvil and stirrup?

5. What part of the body interprets information gathered by the senses?

Homework:

1. Draw a labeled diagram of the ear.

2. Collect or draw several pictures showing ears of different animals.

3. Make a list of 20 sounds you hear while doing your homework. Check those that you would not normally be aware of. Compare your list with the list of another pupil in the class. Did you miss any sounds?

Materials:

1. tuning fork
2. beaker of water
3. ping pong ball
4. string
5. stand
6. whistle
7. shoebox covered with plastic wrap so students can see object inside
8. closed shoebox with loose objects inside
9. model, chart or transparency of ear
10. pictures of animal heads and ears

7. HOW DO THE SENSES WORK TOGETHER?

LABORATORY LESSON

Outcomes:

. The senses work together to help us learn about the environment.

. Sometimes our senses can fool us into making incorrect judgement when they work alone.

Motivation:

Empty the first 4 rows of the classroom. Blindfold one pupil and have him sit in the center of the emptied area. Place 8 pupils in a wide circle around him. Instruct one pupil to snap his fingers and point to another pupil around the circle. The second pupil will snap his fingers and continue the procedure. The blindfolded pupil tries to point in the direction of the sound. Ask the rest of the class to keep score of correct and incorrect responses.

Development:

1. Analyze the results of the correct and incorrect responses. Elicit that sometimes our senses working alone will sometimes mislead us. Pupils should note the difficulty in locating sounds directly in front or in back of blindfolded pupil.

2. Prepare 3 different groups of investigation stations around the room. There should be several groups of each station. Allow pupil to spend about 5-10 minutes at each station. At a given signal have them move on to the next station. Prepare the stations as follows:

   Station #1 - Three beakers of water at different temperatures -
   beaker 1 - warm to the touch (Caution - Not too hot to cause burns).
   beaker 2 - add ice cubes to cool
   beaker 3 - water at room temperature (about 72°F.).
   Label H, C and U respectively.

   Station #2 - Cut small slices of peeled apples and pears.
   Place each into different wax bags.
   Label one A and the other P
   Place one can of cola and one can of fruit soda with cups at this station.

Station #3 - Prepare a set of optical illusion pictures.

3. Distribute worksheets and guide the pupils in performing the investigations.

Homework:

1. List 5 ways in which our senses can be fooled.

2. As a result of your investigation, explain one way 2 senses are better than one in getting information.

Materials:

Blindfolds
Beakers
Hot water
Ice cubes
Slices of apple
Slices of pear
Can of cola
Can of fruit soda (f.s.)
Cups
Set of optical illusion pictures
Wax bags

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON # 7

Problem:

Can we trust our senses?

Introduction:

Man learns about his environment through his senses. But how accurate is this information we receive? Do our senses tell us exactly what our environment is like? Sometimes our senses, working alone, can fool us into making incorrect judgements. This exercise will test whether our senses can be fooled. You will also find out if several senses working together yield more information than one sense alone.

Materials

Beakers of water at different temperatures

Blindfold

Slices of apple

Slices of pear

Cup of cola

Cup of fruit soda (f.s.)

Set of optical illusion pictures

Procedure:

Station #1 - Carefully place one hand into the beaker marked H
How does it feel?_____
Now take your hand out of beaker H and put it into beaker U.
Describe the temperature of the water in beaker U.
_____.
Place your other hand in beaker C.
Describe its temperature._____
Take your hand out of beaker C and put it into beaker U.
Describe the temperature of beaker U now._____

Station #2 - Blindfold your partner. Take a slice of apple from the wax bag marked A and a slice of pear from the

bag marked P. Hold the apple under his nose while he tastes the pear.

What does the fruit taste like?_____.

Do not remove the blindfold. Now hold the pear under his nose while he tastes the apple.

What does the fruit taste like now?_____.

Do the experiment again with 2 pieces of apple, then 2 pieces of pear.

Describe the taste with 2 pieces of apple._____.

Describe the taste with 2 pieces of pear._____.

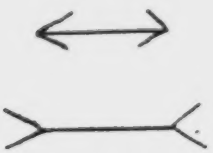
Exchange places with your partner.

Pour cola into one cup and f.s. into another. Hold the cup with f.s. under the nose while the cola is tasted. Reverse the procedure.

Can you identify the difference between cola and f.s. by using taste alone?_____.

What other senses are needed?_____.

Station #3: Examine the illustrations and answer the questions.

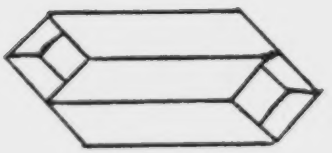


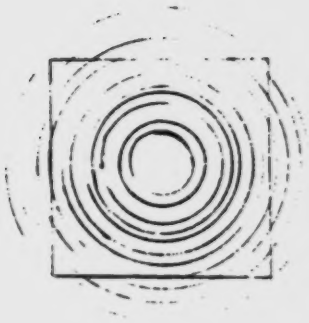
Which line is longer?

_____.

Is the thicker box on the top or the bottom?

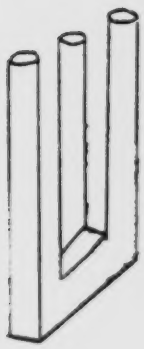
_____.





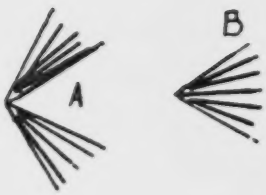
Is the figure inside the circles a perfect square or are the lines curved?

_____.



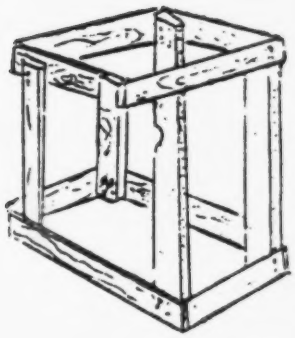
Are there two or three prongs?_____

_____



Is the space marked A bigger than the figure marked B?_____

Is the crate constructed correctly?_____
_____.



Station #4 - Look at a picture on the wall. Place your thumb in front of your eye so that it lines up with the bottom of the picture. Move your index finger until it lines up with the top of the picture. This is how big the picture looks to you.

Is the space between your fingers the actual measurement of the picture?_____
_____.

Conclusion:

1. In what ways do our senses fool us?
2. What can we do to correct this?
3. What do we mean when we say that water is too hot or too cold?
4. What senses are involved with tasting food?
5. Why do we call the pictures at station #3 optical illusions?

8. HOW DOES MAN EXTEND HIS SENSES?

Outcomes:

. Man can extend his senses through the use of instruments.

Motivation:

Question the pupils to find out if anyone has been to a doctor for a physical examination. Ask them to describe what instruments the doctor uses.

Development:

1. Display a stethoscope and elicit that this instrument helps us hear sounds in the body. Instruct the pupils to work in pairs. Have one listen to his partners breathing by placing his ear on his partners back. Using a stethoscope, have him listen again. Guide the pupils to conclude that the stethoscope is an instrument that helps man improve his sense of hearing.

2. Discuss other ways that man can extend his range of hearing. Ask the pupils to estimate about how far they can be heard if they shout. Demonstrate ways of extending the sound of the voice with a megaphone, bull horn (Physical Educ. Dept.) as well as with other forms of loud speakers.

3. Demonstrate and discuss other instruments such as telegraph, telephone and radio for hearing over great distances. Point out that man is able to communicate over a distance of about 240,000 miles. This is the distance the astronauts were when they spoke to the earth from the moon.

4. Allow the pupils to observe some distant object through a pair of binoculars or a telescope. Elicit that this instrument allows man to extend his sense of sight.

   (Note: Many children have never gotten a very close look at the moon. You can use binoculars in the classroom to view the moon because some phases are visible during the early or later part of the school day.)

5. Explain that man is able to look into the ocean and locate objects hundreds of feet below. Have pupils recall how difficult it is for them to see their toes while standing shoulder deep in the ocean. Explain how sonar enables man to 'see' into the ocean. Tell that a sound is sent down into the ocean. When it hits the ocean floor it bounces back. We know the speed of sound in water. By measuring the time the sound was sent out and received back we can figure the distance down to the object. Discuss the use of

sonar in detecting fish, submarines and features (contours) of the ocean floor.

6. Point out that radar works the same way as sonar. Here, radio waves are used instead of sound waves. Discuss the use of radar in aviation and weather prediction.

7. On the chalkboard, list other instruments that help man extend his senses. Suggest such things as the camera, x-rays, tape recorder, cardiograph machine, computer, oscilloscope, microscope, magnifying glass, television, mechanical probes for medical and radio active work. Discuss how each helps and improves man's senses.

Summary:

1. Explain how the following instruments are useful.

   a) telescope b) stethoscope c) megaphone d) camera

2. Draw a diagram and explain how submarines are located using sonar.

3. How is it possible for man to see, hear, and detect smell better than any other living thing in the world?

4. Make a list of 5 instruments that extend our senses. Next to each instrument list which sense it helps.

Homework:

1. A doctor uses many instruments in his work. Some are used to help him make better observations. Make a list of at least 5 such instruments.

2. Cut out pictures from magazines or draw different instruments that are used to aid our senses.

9. HOW DO WE USE INSTRUMENTS TO MAKE MORE ACCURATE OBSERVATIONS OF THE ENVIRONMENT?

(LABORATORY LESSON)

Outcomes:

- Many instruments enable us to gather more accurate information about an environment.
- Measurements are ways of describing an environment.

Motivation:

Have several pupils stand in front of the room and close their eyes. Tell them to raise their hands as soon as they think 2 minutes have passed. Have other members in the class record how accurate they were.

Development:

1. Ask pupils, "How accurate is our judgment in measuring time? Have pupils establish various methods of measuring time. (Example: counting to yourself, taking your pulse, breathing rate.) Elicit that instruments give us a more accurate method of measuring time.

2. Using pictures or transparencies, show and discuss various instruments used to measure time. (Examples: hour glass, water clock, time candle, sundial, watches.)

3. Distribute laboratory worksheets to pupils and inform them that they will be investigating other instruments which we use to measure and describe an environment. (Note: If pupils have never used a triple beam balance, you will have to demonstrate and explain the operation of one.)

Homework:

1. Why do scientists use instruments?

2. How could you describe a shoe box accurately?

3. List 5 instruments that help us make accurate observations.

Materials:

1. Watch with second hand
2. Pieces of dowel sticks
3. Triple beam balance (or spring balance)
4. Thermometer
5. Ruler (inches and centimeters)
6. Beaker with water
7. Empty beaker
8. Graduate cylinder

NOTE:

The introduction to the use of laboratory instruments as a way of enhancing our observations serves as a useful vehicle for introducing the specific skills needed to manipulate the instruments and of enriching the investigations.

It is suggested that sufficient time be alloted for pupils to practice measurements in order to gain facility in using the devices confidently.

In addition to the laboratory experience outlined here, a sequence leading to the further acquisition of techniques is as follows:

- Use of a spring balance to measure weight in ounces and in grams. (Use washers, weights.)
- Changing from one system to another.
- Use of a beam balance to measure weight.
- Comparing the efficiency of a spring balance to a bream balance.
- Measuring dimensions (inches and centimeters) of a regular shaped object (dowel).
- Measuring dimensions of an irregular shaped object. (rocks).
- Measuring volume with a measuring cup (English system).
- Measuring volume using a graduated cylinder (Metric).
- Measuring temperature using Fahrenheit and Celsius scales.

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON 9

Problem:

How do instruments help us make more accurate observations?

Introduction:

Our senses help us gather information about an environment. However, our senses may be fooled or the information gathered may not be exact enough for many purposes. Instruments help us make more accurate observations. In this exercise you will use several simple instruments to get more accurate information.

Materials:

1. Piece of dowel
2. 6 inch ruler
3. Triple beam balance (scale)
4. Empty beaker
5. Beaker and water
6. Graduated cylinder
7. Thermometer

Procedure:

1. Perform all of the tasks listed. As you do record each result in the blanks in the observation.

2. Guess how long your piece of wooden dowel is. Measure it with the ruler. Compare your guess to the actual measurement. How close was your guess?

3. Guess how much the dowel weighs. Weigh it on the balance. Compare your guess with the actual weight. How close was your guess?

4. Look at your graduated cylinder. Notice the markings. Look at the 100 ml line. Look at the empty beaker. Add water to the beaker. Stop when you think it equals 100 milliliters. Pour the water from the beaker into the graduated cylinder. How many milliliters did you actually have in the beaker. How far off from 100 ml were you?

5. Put your finger into the beaker of water What do you think its temperature is? Place a thermometer into the beaker and wait about 3 minutes. Observe and record the temperature. Do the same again after 2 minutes longer. Observe and record the

temperature again. Compare your guess with the reading from the thermometer.

Observations:

1. I estimated the dowel was_____ inches or _____ centimeters.

   Actual measurement was _____ inches or _____ centimeters.

   Difference: _____ inches or _____ centimeters.

2. I estimated the dowel weighed_____ gms.

   Actual weight was _____ gms.

   Difference:_____ gms.

3. Milliliters under or over 100 ml. _____ ml.

4. I estimated the temperature of the water was_____ °C.

   Actual temperature of the water was _____ °C after 3 min.,

   _____ °C after 5 min.

   Difference:_____ degrees

Conclusions:

1. How did the instruments improve your observations?

2. Why do we make measurements of the environment?

10. HOW CAN WE SEE SMALL THINGS IN AN ENVIRONMENT?

LABORATORY LESSON

Outcomes:

- Parts of the microscope work together to enable us to see objects clearer and to see objects that cannot be seen with the naked eye.
- Proper handling of the microscope requires the correct use of each of its parts.

Motivation:

Arrange pupils in small groups and distribute a hand magnifying glass to each group. Instruct one member of each group to remove a hair from his head and let the group examine it. "Ask, "How does the hair appear different? "What details of the hair can you now see using the hand lens?"

Development:

1. Establish that objects look slightly larger with a magnifying glass. Pose the question, "How can the hair be examined so as to see its structure even more clearly?" Elicit that a microscope is a tool scientists use to enlarge objects so as to see them in greater detail.

2. Distribute a microscope and duplicated sheet showing the parts of the microscope, to each group of children. Discuss briefly the parts of the microscope with the class as the pupils point out the various parts on their own microscope.

3. Distribute the laboratory worksheets to the pupils and have them prepare a slide of the hair they had previously examined. Guide the pupils in reading and conducting this activity.

Homework:

Prepare a report on the life and science investigations of Anton van Leeuwenhock, one of the first men to use a microscope.

Materials:

1. Hand magnifying lens
2. Chart on parts of microscope to be distributed to pupils
3. Microscope
4. Slides
5. Coverslips
6. Toothpicks

(DUPLICATE FOR USE BY PUPILS)

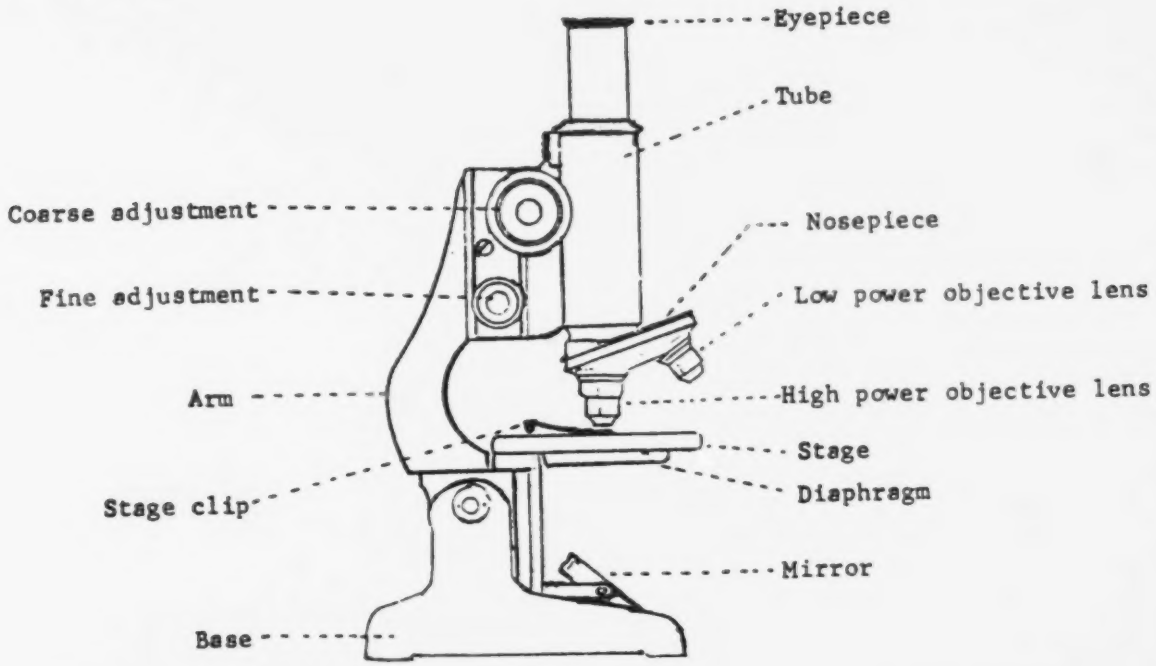
LABORATORY WORKSHEET - LESSON 10

THE MICROSCOPE

1. Study the picture of the microscope carefully. Learn the names of the different parts so that you can follow your teachers directions.
2. Always carry the microscope with one hand holding the arm and the other hand supporting the base of the microscope.
3. The first lens you look through, the EYEPIECE (ocular lens) is located on top of of the microscope.
4. Further down, at the lower end of the tube, you will find the revolving nosepiece. It has two lenses - LOW POWER OBJECTIVE and HIGH POWER OBJECTIVE.
5. A slight push with your fingers on one of the objective will help you change from low power to high power. When an objective lens is in proper position, you will hear a click. Swing the low power into place. How do you know this is the low power?
6. Find the MIRROR underneath the stage. It reflects light through a hole in the stage up to the objective lens.
7. Your microscope will also have a DIAPHRAGM. It is found beneath the stage. It controls the amount of light going through the stage. Why do we want to control the amount of light? Turn the diaphragm. Do you see the numbers that show on top of the disphragm. Which number has the largest opening? Which has the smallest opening?
8. To focus the microscope, find the COARSE ADJUSTMENT wheel. Turn it gently. Notice it moves the microscope tube up and down. The FINE ADJUSTMENT wheel is used to give you a sharp focus AFTER you have brought the specimen in view with the coarse adjustment.
9. The magnification of the microscope is the result of the magnification powers of the eyepiece and the objective:

   eyepiece (10X) times objective (10X) equals 100 magnifications
   eyepiece (10X) times objective (44X) equals 440 magnifications

10. The object you will examine is placed on a glass slide and held in place by STAGE CLIPS.



(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORK SHEET - LESSON 10

Problem:

How do we use a microscope?

Materials:

Microscope	Coverslip
Slide	Toothpick

Procedure:

1. Always hold and carry the microscope with both hands, one on the arm and the other below the base. Why is this important?

2. Using lens paper gently clean the slide, eye piece, objectives, mirror and opening in the stage. Before cleaning, blow gently across these surfaces to remove any dust particles which might scratch them.

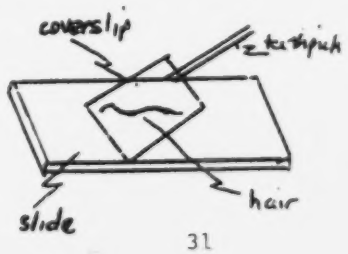
3. Swing the low-power objective into position. How can you tell when it is in place? How can you identify the low-power objective?

4. While looking at its side, lower the tube until the low-power objective reaches the bottom without touching anything. Why should you carefully watch the tube as it is lowered? Which adjustment knob should you use? Why?

5. Bending to the side look under the stage. You should see the diaphragm. Make sure the diaphragm is wide open. Why is this important? What number is the diaphragm set at?

6. Look through the eye piece with one eye. Keep both eyes open. Carefully tilt the mirror until you see a very bright circle of light. Why should this be the brightest circle of light you can get?

7. Place the specimen of hair on the clean slide. Touch one end of a cover slip to the slide and support the other end with a toothpick. Carefully lower the coverslip down onto the slide.

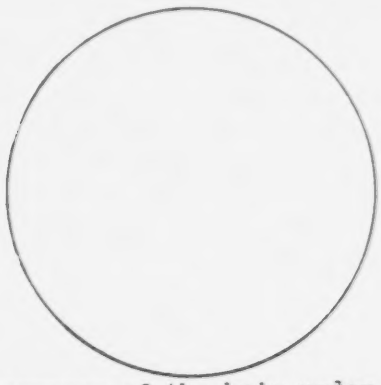


8. Place your slide on the stage and make sure that the hair is directly over the opening in the stage. Place the clips on the slide. Why?

9. While looking through the eye piece, focus upwards slowly, using the large knob (coarse adjustment knob). Never focus downward. Why?

10. Stop when the object is in focus, then use the small knob (fine adjustment knob) to obtain a sharp focus.

11. Draw a diagram of the hair as seen under the microscope.



Summary:

1. Describe the appearance of the hair under the microscope.

2. In what ways does the microscope aid us in examining the hair?

3. How much larger, do you think, the hair appears when it is viewed under the microscope?

4. How does the microscope aid us in studying things?

C. THE CLIMATE AFFECTS THE ENVIRONMENT

11. WHAT IS AIR?

Outcomes:

. Air is a colorless, odorless and tasteless gas.

. Air takes up space and has weight.

Motivation:

Hold up an "empty" jar and ask the pupils what is inside the jar.

(Pupils should answer that the jar is empty. If some respond that there is air inside, ask how they would prove this.)

Development:

1. Demonstrate that an empty jar is not empty at all. It contains air which takes up space. Place a crumpled piece of paper at the bottom of a small jar. Screw the cover on the jar. Invert the jar and place it into a tank of water. Push it entirely under the water. Ask the pupils if they think the paper will get wet. Have them explain why. Remove the jar and have the pupils examine the paper. Repeat the demonstration without the cover on the jar. Again have the pupils examine the paper. Elicit that there was air inside the jar. This air took up space and did not let water enter the jar to wet the paper.

2. Again submerge the jar into the tank of water. This time tilt the glass slightly. Have the pupils observe the bubbles leaving the jar. Draw attention to the fact that the bubbles are air. Indicate that air is a colorless, odorless and tasteless gas.

3. Weigh a deflated volley ball on a balance. Inflate the ball with an air pump. Weigh the ball again. Guide the pupils to see that the increase in weight was due to the air which was added to the ball.

Summary:

1. Set up the demonstration illustrated. Pour water into the funnel keeping the clamp on the rubber tube closed. Open the clamp. Have pupils explain why the water did not enter the bottle until the clamp was opened.

2. What change in weight would you observe if a gallon size tin can was weighed before and after pumping air into it?

3. What is air?

Homework:

1. Why is it so hard to get water into a perfume bottle that has a small opening?

2. Explain why an inflated balloon weighs more than one without air in it.

Materials:

1. Small jar cover
2. Tank of Water
3. Balance
4. Volley ball
5. Funnel
6. Two holed rubber stopper
7. Bottle
8. Small glass tube
9. Small piece of rubber tubing
10. Clamp

12. DOES AIR EXERT PRESSURE?

Outcomes:

- Air exerts pressure equally in all directions.
- Air pressure at sea level is about 15 lbs. per square inch.
- As you go up, air pressure decreases.

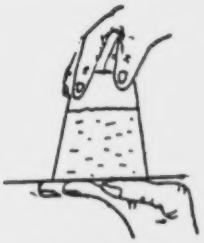
Motivation:

Pour about a half glass of water into a clean gallon can. (Type used for wax.) Heat the can until the water inside boils. When steam comes out of the top cap the can and seal it tightly. Allow the can to cool. (To speed up the cooling process pour cold water onto the can.) Ask the pupils to explain what happens.

Development:

1. Review the properties of air. Point out that air has weight and exerts pressure. Using the motivation, guide the pupils to observe that air pushed the can in. Elicit that when the water was heated, it boiled. The boiling water turned to steam. The steam pushed air out of the can. When the can was cooled, the steam changed back to water. Now there was more air outside the can than inside. The pressure of the air outside caused the can to collapse. Point out that removing some of the air from the can decreased the pressure inside the can.

   Pour some water into a glass. Cover the glass with an index card. Invert the glass while holding the card tightly to the glass. Make sure the card is wet around the rim of the glass.



   Now remove your hand from the cardboard. Ask the pupils what keeps the cardboard from falling? Turn the glass sideways. Elicit that air exerts pressure equally in all directions. Reenforce this concept by showing the pupils that the tin can was pushed in on all sides.

3. Tell the class about Otto von Guericke and his Magdeburg Hemispheres. Use the school Magdeburg Hemispheres to demonstrate how strong air

pressure is. Tell the pupils that at sea level air pushes with a pressure of about 15 pounds on every square inch.

4. Tell the pupils that as you move up away from the earth the air gets thinner. Explain that since there is less air, the pressure decreases. Discuss the problems, airplanes flying at great heights have with pressure. Tell the pupils that miners also have to contend with increased air pressure. The deeper they go, the greater the pressure becomes.

Summary:

1. List all of the properties of air.

2. Measure the area of your desk. (length x width). How many pounds of pressure does air exert on your desk top?

3. If there is more than a ton of pressure on the top of your desk why doesn't your desk collapse?

4. Why does air pressure decrease as you go up away from earth?

Homework:

1. Why do your ears "pop" when you go up fast in an elevator?

2. Why must airplanes flying at great heights have pressurized cabins?

3. Measure the length and width of your hand. Multiply the length by the width to find the area of your hand. How much pressure is acting on your hand?

4. If so much pressure acts on your body, why isn't is crushed?

Materials:

1. Gallon can
2. Glass
3. Index card
4. Magdeburg hemispheres
5. Air pump (exhaust)

13. WHAT ARE SOME APPLICATIONS OF AIR PRESSURE?

Outcomes:

Man has developed many instruments which use air pressure to make work in the environment easier.

Motivation:

Moisten a plunger and place it on the chalkboard. Ask a pupil to come up and remove it. Ask, "What holds the plunger to the board?"

Development:

1. Discuss how a plunger uses air pressure to clear stuffed drains. Show pupils a toy arrow with a suction cup. Guide the pupils to understand that the plunger is a giant suction cup. Draw attention to objects that have suction cups (towel rack holder, tire design and sneaker bottoms). Challenge the pupils to explain how air pressure is used in the operation of each.

2. Inflate a balloon. Elicit that you have air under pressure. "How do we know it is under pressure?" Show them a picture of a skindiver with air tanks on his back. Ask, "How can compressed air be put to work?" Show pictures and discuss the operation of air brakes, sand blasting, pneumatic drill, auto lift, and pneumatic mailing tubes.

3. Place a glass tube into a jar of water. Place your finger over the top of the tube and remove it from the water. Have the pupils note the water in the tube. Remove your finger from the top of the tube. Challenge the pupils to explain why the water stayed in the tube while your finger covered the end, but came out when the finger was lifted. Relate this to the operation of a straw and medicine dropper.

4. Demonstrate and explain the operation of a siphon. Point out that gravity begins the movement of water in the tube. The pressure decreases inside the tube and water is pushed into the tube by the outside pressure.

5. Show a transparency of a vacuum cleaner and explain its operation.

6. With a model of a simple lift pump, demonstrate and explain its operation. If time permits use a model of a force pump and explain its operation.

Summary:

1. Make a list of objects which use air pressure in their operation.
2. Draw a diagram of a vacuum cleaner and explain how it works.
3. Draw a diagram of a lift pump and explain how it works.

Homework:

1. Cut out or draw five or more pictures of objects which use air pressure to do work.
2. Define the word vacuum.
3. Why is the machine which removes dirt from a rug called a vacuum cleaner?

Materials:

Plunger	Objects with suction cups
Balloon	Lift pump model
Glass tube	Force pump model
Glass of water	Assorted charts and pictures

14. WHAT IS THE ATMOSPHERE?

Outcomes:

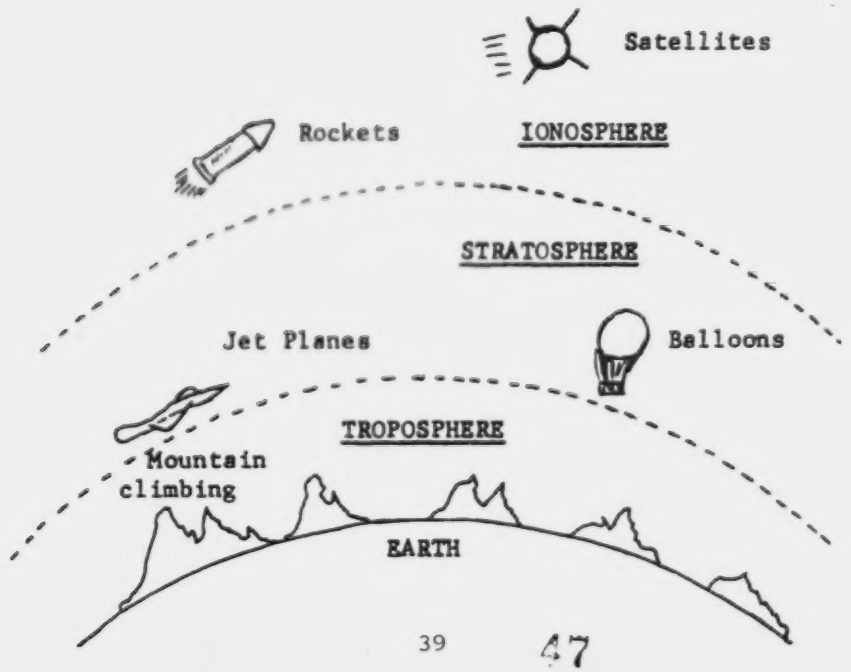
- The atmosphere is the region which surrounds the solid and liquid parts of the earth.
- The atmosphere can be divided into three main layers: troposphere, stratosphere and ionosphere.
- The troposphere is the region closest to the earth and is a region of changing weather.

Motivation:

Write the following on the board "We live at the bottom of an ocean of air." Ask the pupils to explain what is meant by the statement. Refer to the reports given by the astronauts as they moved away from earth. "What did the sky look like?" "Why did it get dark?"

Development:

1. Elicit that the ocean of air that surrounds the earth is called the atmosphere. Compare man in his ocean to a fish in its ocean. "Why is air so important to man?"
2. Challenge the pupils to describe ways that could be used to study the atmosphere. Elicit that man has explored the atmosphere using balloons, jet planes, mountain climbing, rockets and satellites.



From observations made, we divide the atmosphere into three regions: the TROPOSPHERE, STRATOSPHERE, and IONOSPHERE. Add these names to the diagram. Elicit that as you go up into the troposphere the air gets colder and thinner.

3. Indicate that the stratosphere absorbs some of the suns rays which are harmful to us. Tell the pupils that ordinary radio waves are reflected back to earth by the ionosphere and this enables us to send radio messages around the earth. Point out that at times this layer glows to produce what we call an AURORA. Guide the pupils to see that it is the troposphere that directly affects our environment.

4. Distribute different weather reports from newspapers. Have the pupils list the factors of weather. (Air temperature and pressure, humidity, wind speed and direction, amount of clouds, rainfall and sunshine.) Elicit that weather changes from day to day. Tell the class that weather changes only in the troposphere. There are no clouds or water vapor above the troposphere.

Summary:

1. What is the atmosphere?

2. Name the regions of the atmosphere.

3. What are the factors of weather?

Homework:

1. Why do airplane pilots prefer to travel above the troposphere.

2. Why are radio engineers interested in the ionosphere?

3. Why are we most interested in the troposphere?

Materials:

Newspaper weather reports

15. WHAT IS THE COMPOSITION OF AIR?

Outcomes:

- The air is a mixture of gases.
- These gases include oxygen (about 20%), nitrogen (about 78%) carbon dioxide (about .04%) and about 1% other gases.
- Air also contains particulate matter (dust, pollen)
- Dust and gases from industry and traffic add pollutants to the air

Motivation:

Light a candle. Hold up a beaker and challenge the pupils to predict what will happen if the candle is covered by the beaker.

Development:

1. Place the beaker over the candle. Elicit that the candle needs air to burn. Tell the pupils that air is a mixture of gases and one of these gases is needed for burning. Can they identify it?

2. Prepare a test tube of oxygen. (Oxygen may be made by placing a little manganese dioxide into a test tube and adding 3% solution of fresh hydrogen peroxide). Place a glowing splint into a test tube of air and another glowing splint into a test tube of oxygen. Tell the pupils that the gas which is needed for burning is oxygen. Encourage the pupils to suggest the names of some other gases found in air. List the names and amounts of each on the chalkboard.

3. Challenge pupils to predict what would happen if all the air were oxygen. Elicit that nitrogen dilutes the oxygen and prevents everything from burning up rapidly.

4. Moisten a section of the chalkboard. As the water disappears, ask the pupils, "What happened to the water?" Elicit that it enters the air. Point out that there is always water vapor in the air, but the amount varies.

5. Tap an eraser on the chalkboard. Draw attention to the dust particles floating in the air. Elicit other particles that may be found in air. Mention that factory chimneys and automobile exhausts send pollutants into the air. Briefly discuss the problem of air pollution.

Summary:

1. Make a chart showing the names of the gases and percentages of each found in the air.
2. What do we find in the air beside gases.
3. What are the biggest sources of air pollution.

Homework:

1. List some uses of oxygen.
2. List a use of nitrogen.
3. Why we expect to find a great deal of air pollution around New York City?

Materials:

Candle	Manganese dioxide
Beaker	Hydrogen Peroxide (3%)
Test Tubes	Splints

16. HOW ARE WEATHER FACTORS OF THE ENVIRONMENT MEASURED?

(LABORATORY LESSON)

Outcomes:

- Weather is the daily condition of the atmosphere.
- Instruments help us measure weather factors.

Motivation:

Ask pupils to write a report of the weather as it appears at the moment insofar as they can observe.

Development:

1. Ask several pupils to write their reports on the board. Review the other factors of weather and list them too. Direct the pupils to examine their reports to see if they have included each factor.

2. Elicit that instruments help us gather information and measure an environment.

3. Distribute laboratory worksheets to pupils and inform them they will be investigating instruments which measure and describe the weather factors of an environment. Prepare six stations with a different weather instrument at each station.

   Allow the pupils to spend some time at each station and then move on to the next. The lesson would be even more meaningful if the laboratory could be set up outside of school.

   Prepare the stations as follows:

   Station #1 - Anemometer

   Station #2 - Wind Vane

   Station #3 - Thermometer

   Station #4 - Beaker of water, psychometer (Inexpensive psychometers can be purchased from catalogs featuring ESCP program)

   Station #5 - Rain gauge

   Station #6 - Aneroid barometer

   Duplicate stations will allow smaller groups to work at a station.

Homework:

1. List the instrument used to measure:

   a. Wind speed
   b. Wind direction
   c. Air temperature
   d. Humidity
   e. Amount of precipitation
   f. Air pressure

2. Make a weather instrument

Materials:

Anemometers
Wind vanes
Thermometers
Rain gauges
Aneroid barometers
Psychrometers

Class Project: Pupils could set up a weather station. Information gathered each day could be compared with radio or newspaper reports.

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON 16

Problem:

How do we measure weather factors?

Introduction:

Weather is the daily condition of the atmosphere. You know that instruments help us gather information useful in describing our environment. In this exercise you will study different instruments used to measure weather factors.

Materials:

Anemometer	Psychrometer	Wind Vane
Barometer	Rain gauge	
Beaker of water	Thermometer	

Procedure:

Station #1 - This instrument is called an anemometer. Look at the list of weather factors. Which factor do you think this instrument measures? _____. Blow gently at the cups; now harder. Describe what happens. _____. What instrument would be attached to the anemometer to tell how fast it turns? _____ _____. Describe how you could build one of these at home. _____ _____

Station #2 - This instrument is called a wind vane. What does it tell you about the weather? _____. Blow hard at the arrow. Does the arrow point toward or away from you? _____. Does the arrow of a wind vane point toward the direction the wind is going or the direction it is coming from? _____.

Station #3 - What factor of weather does this instrument measure? _____. What does it read? _____ ^{o}F

Station #4 - This instrument is called a psychrometer. It measures relative humidity. Humidity is the amount of moisture in the air. Note that one thermometer has the bulb covered with a piece of cloth. Dip this thermometer into water so that the cloth gets wet. Keep the other thermometer dry. Now hold the wooden handle and spin both thermometers.

After about 3 minutes stop the spinning. What is the temperature of the dry thermometer? _____ ^{o}F, the wet thermometer? _____ ^{o}F. Your teacher will have a chart which can tell you how to figure out the relative humidity.

Station #5 - This instrument is called a rain gauge. What do you think it measures? _____. Describe how you could build one of these at home. _____
_____.

Station #6 - This is called a barometer. It measures air pressure. Normal air pressure if 29.92 inches. What is the air pressure shown on your barometer? _____ inches. If the barometer is above 29.92 the weather is usually clear. If it is below 29.92 it may rain. What does your barometer predict? _____(rain or clear)_____

Conclusion:

1. What is weather?

2. Draw a diagram of each weather instrument.

17. WHAT IS CLIMATE?

Outcomes:

- Climate in the condition of the atmosphere over a long period of time.
- Precipitation and temperature are the principle elements of climate.

Motivation:

Tell the pupils that each row has won a free trip. However, they may pack only one suitcase. The first row will leave on December 21 for the North Pole, the second row on December 21 for Florida; the third row on July 1 for the Sahara Desert in Africa; the fourth row on July 1 for the Amazon jungle. The fifth and sixth rows will be substitutes in case the others get sick. Have each pupil describe the type of clothes he or she will take.

Development:

1. Guide the pupils to see that weather of a region determines how a person will dress. Have the pupils describe the weather of each place when they will be there. Call attention to the fact that some regions have almost the same weather all year long (Sahara, Amazon) and in others the weather is changeable (N.Y., Chicago) Point out that weather over a long period of time is called climate.

2. Elicit that temperature is one important element of climate. List the average yearly temperatures for several cities and ask the pupils to describe the climates of these cities using items such as hot, cold or temperate. Using a wall map of the world guide the pupils to see that the hot climates are located near the equator, while the colder one are located near the poles.

3. Have the pupils compare a jungle climate to a desert. Elicit that precipitation is the major factor which makes these climates different. Ask pupils to compare a number of cities' average yearly rainfall. Identify the cities as wet, dry or moderately wet or dry climates.

4. Point out that the amount of precipitation does not always determine if a climate will be wet or dry. Introduce the Water Budget concept by filling a paper cup with water. Tell the pupils that water entering the cup represents precipitation. Make a hole in the bottom of the cup. Call attention to the water leaving the

cup. Compare this to water leaving the ground by evaporation. Elicit that if evaporation is greater than precipitation a dry climate will result. If precipitation is greater than evaporation a wet climate results.

5. Explain other factors that may affect climate. Include altitude, ocean currents, winds and mountains.

Summary:

1. What is meant by climate?

2. What are the two major factors that influence climate?

3. What are some other factors that influence climate?

4. Describe the climates of the following areas.

City	Average Yearly Temperature	Average Yearly Rainfall
Iquitos, Peru	79°F	103 in.
Mongalla, Sudan	79°F	38.8 in.
El Obeid, Sudan	79°F	14 in.
Salah, Sahara	78°F	0 in.
Barrow, Alaska	10°F	6.4 in.
New Orleans	68°F	56 in.
New York	50°F	24.5 in.
Antarctica	- 14°F	under 10 in.
Akyab, Burma	79°F	202.9 in.

Homework:

1. Why is it so important to know the climate of a region?

2. How is it possible for a city to have a great deal of rainfall and still have a very dry climate.

3. How does the Gulf Stream affect the climate of England?

Materials:

Chart showing average yearly temperature for various cities.
Chart showing average yearly rainfall for various cities.
Paper cup.

18. WHAT ARE SOME FACTORS WHICH AFFECT CLIMATE?

(LABORATORY LESSON)

Outcomes:

. Land surfaces heat faster than water.

. A breeze results when cooler air moves toward an area of warmer air.

. Dark colored objects heat up faster than light colored objects.

Motivation:

Ask pupils to describe the climate of the mid-eastern and north African region. Describe the type of clothes appropriate for such a climate.

Development:

1. Based on the motivation, elicit that the people dress in white colored clothing to protect them from the sun. Why is the color of the clothes important in relation to climate?

2. Have the pupils describe the temperature of the beach sand and ocean water on a hot summer day. Pupils should conclude that the land gets hotter than the water.

3. Tell the pupils that they will perform two simple experiments to show the effects of heat on:

   a) different colored materials

   b) water and land

   Distribute worksheets and guide the pupils in performing the investigation.

   Paint ½ of the cans black for this investigation.

Homework:

1. Which color road gets hotter in sunlight, a black top or light-color cement? Explain why.

2. Would you expect to find a beach area cooler in the summer? Explain why.

3. Would you expect to find a beach area warmer in the winter? Explain why.

Materials:

Light and dark colored cans

Styrofoam covers

Thermometers (-20°C to 50°C)

Lamps with 100 watt bulb

250 ml. beakers

Stands

String

Sand

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON 18

Problem:

A. What is the effect of heat on light colored and dark colored objects?

Introduction:

People living in tropical climates often wear light-color clothing, while people living in areas away from the tropics wear dark color clothing. Is this a coincidence or is there a scientific reason for this?

Materials:

Light color can
Dark color can
Styrofoam cover for each can
Two thermometers
Lamp assembly
Watch or clock

Procedure:

1. Place the cans equal distance from the lamp.
2. Push the thermometers through the slot in the styrofoam covers.
3. Cover each can. MAKE SURE THAT EACH THERMOMETER DOES NOT TOUCH THE SIDES OR BOTTOM OF THE CAN.
4. Turn the light on and record the temperatures each minute for 10 minutes, or until the temperature reaches 45°C.

Observation:

	Light color can	Dark color can
Temperature at start of experiment	____°C	____°C
" after 1 minute	____°C	____°C
" " 2 "	____°C	____°C
" " 3 "	____°C	____°C
" " 4 "	____°C	____°C
" " 5 "	____°C	____°C
" " 6 "	____°C	____°C
" " 7 "	____°C	____°C
" " 8 "	____°C	____°C
" " 9 "	____°C	____°C
" " 10 "	____°C	____°C

Conclusions:

1. Which color can heated fastest? _____.

2. How much hotter did it get? _____.

3. The thermometers were actually measuring what temperature?_____
_____.

4. Can you give a scientific reason why one can got hotter than the other?

5. Why do people in the tropics wear light color clothing?

Problem:

B. How does heat affect land and water?

Introduction:

On a hot summer day the sand on the beach gets very hot while the water stays cool. At night the reverse is true, the sand feels cool and the water feels warmer. What is the importance of this?

Materials:

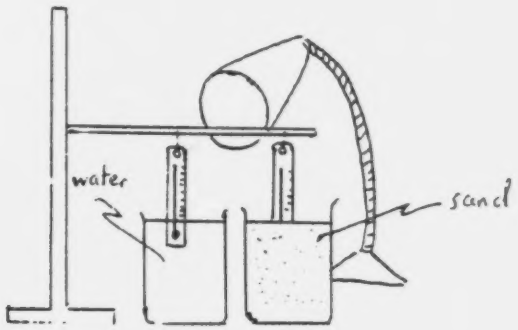
Stand
Two thermometers
Two 250 ml beakers
Sand
Water
String
Lamp
Watch or Clock

Procedure:

1. Place the heat lamp about a foot away from two beakers.

2. Fill one beaker with water, the other with sand.

3. Tie 2 thermometers to a stand and lower each so that both are just below the surface of the water and sand.



4. Turn the light on and record the temperature each minute for 10 minutes.

5. Turn off the light and continue recording the temperature each minute for 10 minutes.

Observations:

With light on		Time	With Light off	
Water	Sand		Water	Sand
_____°C	_____°C	at start of experiment	_____°C	_____°C
_____°C	_____°C	after 1 minute	_____°C	_____°C
_____°C	_____°C	" 2 minutes	_____°C	_____°C
_____°C	_____°C	" 3 "	_____°C	_____°C
_____°C	_____°C	" 4 "	_____°C	_____°C
_____°C	_____°C	" 5 "	_____°C	_____°C
_____°C	_____°C	" 6 "	_____°C	_____°C
_____°C	_____°C	" 7 "	_____°C	_____°C
_____°C	_____°C	" 8 "	_____°C	_____°C
_____°C	_____°C	" 9 "	_____°C	_____°C
_____°C	_____°C	" 10 "	_____°C	_____°C
_____	_____	"	_____	_____

Conclusion:

1. Which heats faster, water or sand?_____.

2. Which cools faster, water or sand? _____.

3. In the daytime which heats faster the land or the ocean?_____.

4. At night which heats faster the land or the ocean? _____.

Breezes are caused when air moves from cool regions to warm regions.

5. In the day which way does the breeze blow? (ocean to land or land to ocean.)

6. At night which way does the breeze blow? (ocean to land or land to ocean.)

19. HOW DOES THE CLIMATE AFFECT THE ENVIRONMENT?

Outcomes:

- The climate of a region greatly affects the living things in the environment.
- The community of plant and animal life in a region with one kind of climate is called a BIOME.
- Changes in climate result in changes in the environment.

Motivation:

Draw on pupil experiences (movies, T.V., pictures) or show a film comparing various biomes. National Audubon Society has available ecology charts detailing various biomes. Select two extreme biomes (i.e. tropical rain forest and desert). Ask the pupils to use their imagination in describing the main features of each (climate, amount of water, types of plant and animal life, etc.).

Development:

1. Encourage pupils to speculate about the nature of the climate in a tropical rain forest. Elicit that this forest is a result of the climate. Develop the understanding of the great variety of plant life in the region. Discuss the hundreds of spcies, the very tall trees and the broad leaves. Call attention to the lack of vegetation on the forest floor. Have the pupils explain the reason for this. Show pictures of vines climbing trees to get sunlight.

2. Discuss the high humidity of the forest. Tell the pupils of plants which take their moisture from the air instead of the soil (orchid).

3. Guide the pupils to see that most of the food and protection is found in the trees. Ask them where they would expect to find most of the animal life in this region. Have them give examples of animal life such as birds, monkeys, snakes, and insects.

4. Using the picture of the desert, have the pupils describe its climate. Tell the pupils that the relationship between plant and animal life and climate is called a biome. Elicit the types of plans and animals found in this biome. Point out that in order to preserve water, desert plants are thick, tough skinned, and have modified leaves. Ask, "What kind of root system would you expect desert plants to have?" Have pupils identify the animals of the desert (lizard, snakes, kangeroo rats, camels). Discuss methods of surviving desert heat (burrowing or night activity) and dryness (storing water, conserving water).

5. Ask, "How many pupils have been to the country in the summer?" Have them describe the forests. Make a list of the coniferous and deciduous trees. Elicit that the climate varies in rainfall and temperature. Point out that the deciduous trees lose their leaves. List the animals

found in this region. Discuss migration and competition among the animals for food.

6. Show pupils pictures of a grassland biome. Tell them that grasslands are a result of long periods of drought and then some periods of rainfall. Have pupils recall western movies about the prairies. Elicit from pupils the names of grassland animals such as bison, zebras, antelope, giraffes, lions, leopards, cheetahs. Guide them to see that some animals eat the grass and others eat the grass-eating animals. Tell the pupils about "Buffalo Bill" and the destruction of the bison. "What kind of insects would you expect to find in a region of grasslands?"

7. Discuss the climate of the tundra. Using pictures, call attention to dwarfed plants. Show examples of mosses and lichens. Elicit that these are the main forms of plant life in the tundra. Have pupils identify tundra animals such as caribou, lemming, reindeer, musk-ox, rabbit, fox, weasel and snow owls.

8. To explain how changes in the climate affects the living things in the environment, relate that scientists have discovered fossil evidence of living things in parts of Texas (semi-desert areas now) that were known to have lived only in warm forests and swamps. "What does this tell you about the climate of that region since then?" "Does a change in the climate affect the living things?"

9. To enhance pupil experiences in regard to various biomes, plan this unit around trips to the Botanical Gardens (hot houses) and the Museum of Natural History (comparing different biomes). Using large jars or fish tanks, encourage pupils to recreate simple models of biomes using inexpensive material purchased from an aquarium store or hobby shop.

Summary:

1. How does climate affect the environment?

2. What is a biome?

3. Complete the following chart.

Biome	Type of Climate	Kinds of Plants	Kinds of Animals
A. Tropical rain forest			
B. Desert			
C. Tundra			
D. Grassland			
E. Deciduous and Coniferous forest			

Homework:

1. Draw or paste together a scene showing one or two different biomes. Include as many plants and animals as possible.

2. Describe what would happen if:

   a. it stopped raining and became cold in a tropical rain forest.

   b. it became warm for a long period of time in the tundra.

   c. it began to rain hard everyday in a desert.

Materials:

Pictures of the various biomes
Mosses
Lichens
(Note: Keep pupils' homework pictures to build up file on climatic regions.)

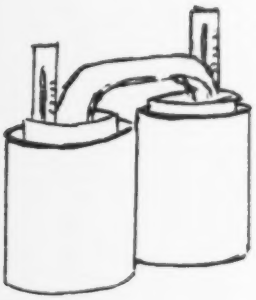
20. HOW IS HEAT ENERGY MOVED IN AN ENVIRONMENT?

Outcomes:

. Heat is transferred by conduction, radiation and convection.

. Heat moves from higher to lower temperature.

Motivation:

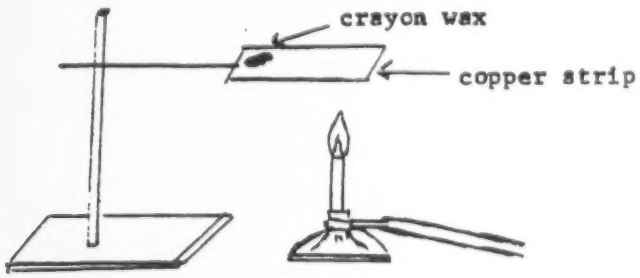


Prepare and demonstrate the following model. Put boiling water into one calorimeter* and water at room temperature in the other. Cover both containers and tell the pupils that they are insulated. Place thermometers into each and connect the two with a metal bar. Have students observe and record the temperature every five minutes for 20 minutes. (*Note: Insulated calorimeters can be made with styrofoam cups.)

Development:

1. Ask pupils to predict the temperature changes that could occur in the motivation demonstration. List these predictions on the board. After all recordings are made, lead pupils to see that heat moves from regions of higher to lower temperatures.

2. Demonstrate heat transfer by conduction with the following demonstration. Attach a six inch strip of copper to a stand. Place a small piece of crayon on the end attached to the stand. Heat the other end of the strip. Call the pupils' attention to the melting wax. Elicit that heat is being transmitted along the metal. Write and define the word conduction on the chalkboard.



3. Using a Convection Box and smoke paper or smoking rope (window shade rope works well), show that the air over the burning candle is moved upward by cooler air. Elicit that the air over the burning candle is

heated. It expands and becomes lighter than cooler air. The cooler air will move under and force the lighter air upward. This sets up convection currents. Point out that heat is moved with these currents.

4. Shine a light on a thermometer on the demonstration table. Have several pupils observe the thermometers and relay to the others what happens. Establish that energy is being transmitted, but not by convection or conduction. Tell the pupils that the energy is being transferred by radiation. Elicit that the sun heats the earth by radiation.

Summary:

1. What are three ways heat energy is transmitted?
2. Where would you find the coolest air in a room?
3. In what direction does heat move?
4. Why does warm air rise?

Homework:

1. Are the following heated by conduction, convection or radiation?
   a) food cooked in a pot
   b) the inside of a closed car gets very warm on a summer day
   c) warm air and smoke escape through a chimney
   d) the handle of an iron pot gets hot when the pot is held in a flame
   e) the warmest part of a room is near the ceiling
2. Where is the coldest part of a refrigerator? Explain your answer.

Materials:

Two calorimeters	Strip of copper	Stand
Boiling water	Crayon	Light
Two thermometers	Convection Box	Candle
Metal bar	Smoke paper or rope	

21. HOW DO LIVING THINGS ADAPT TO CLIMATE?

Outcomes:

- Living things survive because they can adapt to their environment
- Living things have different ways of adapting to their environment

Motivation:

What happens to life in a lake when the top freezes over? What does hibernation mean? Could tropical birds and animals live in New York City all year long? By means of similar questions, encourage pupils to speculate about the inter-relationship between climate and survival of living things.

Display some earthworms that have been kept in the refrigerator overnight. Describe their behavior.

Development:

1. Elicit that temperature is an important factor if an organism is to survive in an environment. Show pupils some begonia plants. Ask them to suggest an experiment with the plants which will show that temperature is important for a plant's survival. If pupils suggest using the refrigerator, ask them to consider what controls they would have to include so as to prove that it was the cold and not the lack of light which affected the plants.

2. Ask pupils to name animals found in the tundra region. Show pictures of polar bears, arctic foxes, ermine, lemming, penguin, ptarmigan, seal, vole and snowy owl. Elicit that a thick coat of fur or feathers helps keep these animals warm. Compare the animals coats with coats worn by pupils in the winter. Point out that the coat helps keep in body heat.

3. Have pupils recall stories about Eskimo life. Ask, "What is blubber?" and "How do the Eskimos use it?" Tell the pupils that this extra layer of fat (blubber) helps keep animals of the tundra region warm. Also, the oil secreted on the surface of some arctic animals' bodies keeps the icy water from wetting them. Encourage pupils to report or draw pictures about the animals found in these cold climates.

4. Distribute patches of moss to the pupils. Challenge them to describe the environment of the plant: Moist or dry, direct sunlight or shade, long or short growing season (short growing season-stunted growth),

hot or cold. Have each pupil explain his choice of environment. Explain that moss needs a moist environment and shade (sunlight would dry it out). Elicit that moisture is an important factor affecting organisms within an environment.

5. Display a cactus, a leaf from a deciduous tree and a pine needle. Ask, "Which plants leaf has the largest surface area?" Elicit that the plant with the largest surface would lose the most water. Then have the pupils explain which plant is best adapted for a dry region and which for a moist region.

6. Discuss hibernation (winter dormancy) and estivation (summer dormancy). Point out that these too are ways animals adapt to climate extremes.

7. Elicit that some birds adapt to changes in climate by migrating. Discuss the whooping crane that lays its single egg in central Canada, raises its young there and leaves for Texas when winter comes.

8. Finally, point out that many trees and plants (Mimosa, Morning Glory) also close their leaves and flowers at night to conserve water.

Summary:

1. Make a list of animals and for each list a way it adapts to its environment.

2. How does fur keep an animal warm?

3. Why is moss found growing under trees?

4. Does the size of a leaf have anything to do with the climate?

5. Why do birds migrate.

Homework:

1. Define hibernation and list some living things which hibernate

2. Choose any 2 living organisms and write a report on how it is able to survive in its climate.

Materials:

Pictures of arctic animals

Moss

Cactus

Leaf of oak, maple of other deciduous tree

Pine needle

Earthworms

22. HOW DOES MAN CHANGE HIS OWN ENVIRONMENT?

Outcomes:

- Humans change their own environment by building different types of shelters.
- Heating and air conditioning systems help people create their own environment.

Motivation:

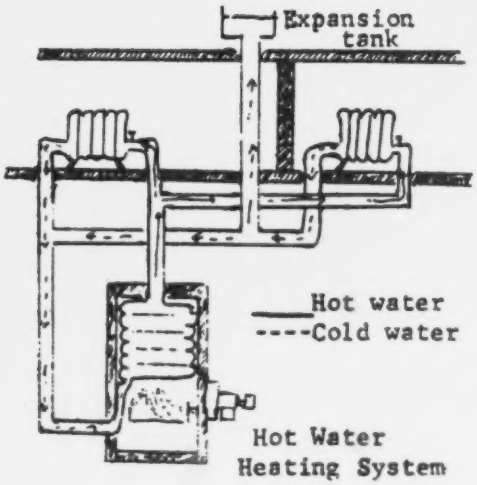
State the following, "Everybody talks about the weather, but nobody does anything about it." Ask the pupils, "How true is this statement?"

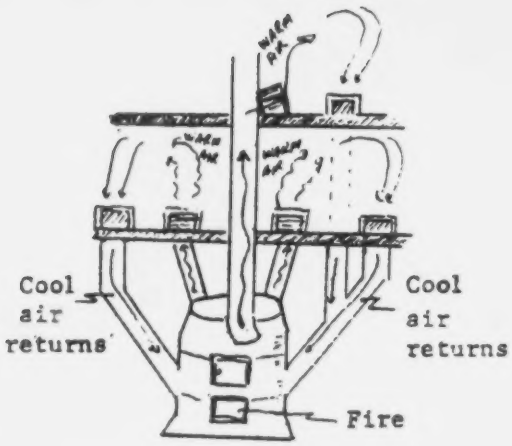
Development:

1. Elicit how people are able to control their climate. With heating and cooling systems people can control temperature; with humidifiers and dehumidifiers they can control the amount of moisture in their environment.

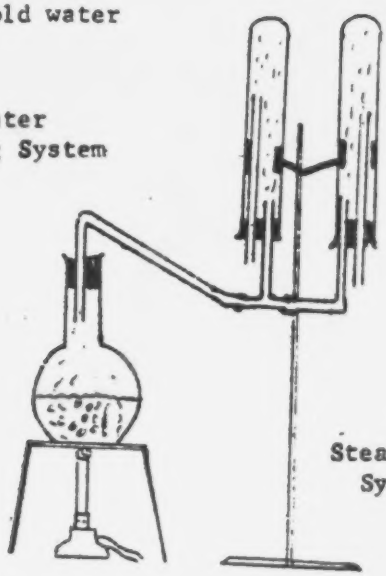
2. Have pupils list various methods used by man in the past to heat his shelters. Review older methods such as open fire, fireplace, Franklin stove. Examine the weaknesses of these older methods. Have pupils identify the fuels used to heat the shelters.

3. On the chalkboard list the major heating systems used to heat most homes today. Display an electric heater and elicit that it radiates heat.
   Display a convection box and with a diagram explain how a hot air heating system works. Elicit that this heat is transferred by convection currents.
   With a large diagram explain the operation of a hot water heating system. Identify the furnace, boiler and radiators.
   Guide the pupils to see that convection currents also transfer heat within a liquid as well as in air. Ask the pupils, "What will happen if the water gets too hot and starts to boil?" Explain the purpose of the expansion tank in this system.
   Set up a model or use a large diagram to explain how a steam heating system works. Compare the merits of the various systems.





Hot Air Heating System



Steam Heating System

4. Use a CO_2 cartridge held in a clamp to show how the release of a gas under pressure cools the cartridge. Relate this to the coils in a refrigerator and air conditioner. Explain the operation of an air conditioner.

5. Place some ice in a tin can. Call the pupils attention to moisture that condenses on the cans surface. Ask the pupils to recall seeing water dripping from an air conditioner. Relate the tin can to the method of removing water from the air to the cooling coils of an air conditioner.

Summary:

1. List 4 types of heating systems used in many homes.
2. Make a chart listing the good and poor features in each.
3. How is moisture added to a room?
4. How is moisture removed from a room?

Homework:

1. Why would radiators in a steam heating system get hotter than those in a hot water heating system?
2. Explain why it is best to place a radiator near the floor rather than near the ceiling.
3. Which type of heating system would you choose for your home? Explain why.
4. Why does an air conditioner need a motor?

Materials:

Convection box
Tripod
Burner
Flask of water
Test tubes
Stand
Glass tubing
Rubber tubing
Tin can
Ice cubes
Various types of humidifiers

D. ANOTHER ENVIRONMENT

23. WHAT ARE THE DIFFERENT AQUATIC ENVIRONMENTS?

Outcomes:

- Plants and animals living together in the same environment form a community.
- A community that exists in a lake, river or ocean is an aquatic community.
- In an aquatic environment temperature and light decrease with depth.

Motivation:

List the following on the chalkboard:

Fish, cow, clam, eagle, seaweed, maple tree, eel, butterfly, turtle, girl, cactus, lion, lobster, snake, pigeon, frog, pine tree, seal, horse, shrimp, monkey, penguin, worm, grass.

Then ask the pupils to group them in some way. Tell the pupils that they will have to explain the groupings.

Development:

1. Allow pupils to explain how they grouped the organisms. Guide the pupils to understand that some plants and animals were grouped together because they live in the same environment. Tell them that plants and animals living together in the same environment form a community. Have them identify some communities from their groupings. Point out that some organisms may be found in two or more communities.

2. Have the pupils recall the aquarium set up in Lesson #2. Ask the pupils to identify the type of community that exists in the aquarium. Ask the pupils to describe other types of aquatic environments and list them on the chalkboard. (pond, lake, stream, ocean).

3. Elicit the plants and animals found in the various aquatic communities. On the chalkboard construct a chart listing the organism and their community. Specific names are not necessary at this point. (e.g. - Pond Lake Stream Ocean)

4. Have the pupils recall from Lesson #2 that temperature and light are

some physical factors of an environment. Relate these factors to an aquatic environment and explain that the amount of sunlight diminishes as you go deeper into the ocean. Point out that at great depths there is no light.

5. Ask the pupils, "What happens to the temperature as you go deeper into the ocean depths. Conclude that as the light decreases, so does the temperature. Call attention to the relationship between climate and water temperature. (Surface temperature is 27°F. in polar regions, 80°F. at the equator). How does that affect the type of life forms that live there?

Summary:

1. What is a community?

2. List the various kinds of aquatic communities.

3. Explain why deep sea divers carry flashlights when they go down into the ocean.

4. What happens to the temperature as you go down into the ocean?

Homework:

1. Copy the list of the various aquatic environments. Choose one and do any of the following;

   a) Write a report describing the kinds of plants and animals found in that community.

   b) Make a drawing showing the kinds of plants and animals found there.

   c) Write a report about one of the plants or animals found in that community. Describe its color, how it eats, how it reproduces, how it takes care of its young and what animals eat it.

Materials:

Aquarium
Pictures and films relating to aquatic environments.

24. HOW DO LIVING THINGS ADAPT TO DIFFERENT AQUATIC ENVIRONMENTS?

Outcomes:

- Aquatic organisms are influenced by physical factors of their environment.
- Certain living things have adaptations which enable them to exist in an aquatic environment.
- Water exerts pressure which increases with depth.

Motivation:

Place the funnel end of a manometer into a tank of water. Ask the pupils, "What does this instrument show?"

Development:

1. Demonstrate with a manometer that water exerts pressure. Lead the pupils to see that pressure increases with depth.
2. Have the pupils recall how an organism must adapt to its environment in order to survive (Lesson #21-Climate). Ask what affect would pressure have on life in the depths of the ocean. Tell the pupils about the bathyscaphe Trieste and the types of animals discovered at depths of 7 miles. Elicit that animals living at great depths would have to be able to withstand these great pressures as well as darkness and cold. Show pictures of spidery starfish as well as other fish that live at great ocean depths.
3. Discuss bioluminescence - what function does it serve? Assign reports and encourage pupils to cut out pictures from magazines (National Geographic) for the bulletin board.
4. Ask pupils to recall the taste of sea water. Elicit that the amount of mineral matter in the water affects that environment also. Demonstrate this by evaporating some tap water from one dish and clean sea water from another. (Dissolve salt in water if sea water is not available.) Ask pupils, "What would happen to a salt water fish placed in fresh water or a fresh-water fish placed in salt water. Conclude that each fish can only live to its own environment to survive. Is it possible for a fish to adapt to a new environment? How? Challenge the pupils to explain how some fish are able to live at the mouth of a river.
5. Examine a fish and draw a diagram of it on the chalkboard. Explain how fish have adapted to their environment. Discuss gills, fins, tail, swim bladder, and stream-lined shape.

6. Examine a clam or other shellfish. Draw a diagram of its features. Show how it is able to adapt to its environment. Include movement, protection, food getting and respiration.

7. With the use of pictures or actual specimens examine as many other aquatic animals or plants as time permits. In each case show how each is able to adapt to its environment.

Summary:

1. What is a manometer?

2. Why can't divers go down too deep into the ocean?

3. How does bioluminescence help a fish?

4. What is the difference between fresh water and sea water?

5. Draw a diagram of a fish. Include its gills, fins, tail,

6. How do the following help a fish: gills, fins, tail, swimbladder, shape?

Homework:

1. Write a report on some aquatic animal or plant and explain how it is able to survive its environment.

Materials:

Manometer

Pictures of deep sea animals

Seawater

Two evaporating dishes

Other aquatic plant and animals or pictures of them

Tripod

Burner

Clam

Fish

II. INTERACTIONS IN THE ENVIRONMENT

A. LIFE ACTIVITIES

25. WHAT DO LIVING THINGS NEED TO SURVIVE?

Outcomes:

- Most living things require food, oxygen and water to survive.
- Each living thing has a temperature range at which it is most comfortable.

Motivation:

Challenge the pupils to compare the earth to a spaceship. A spaceship must supply the astronauts it carries with all their needs. Elicit those needs which are important to living things.

Development:

1. Ask pupils to describe some of the needs of their pets. Elicit that pets have to be supplied with food and water. "Are they important to other living things?" Identify food and water as two of the needs of all living things.

2. Pose the question, "Why do skin divers carry tanks of oxygen under water?" Elicit that most living things need oxygen to survive. Refer back to Lesson 12 on The Composition of the Air. Elicit that most living things obtain the oxygen they need from the air.

3. Show the class an aquarium. Ask "How do fish get oxygen to survive?" The fish get oxygen from the water. (NOTE: This is oxygen dissolved in the water and not part of the H_2O molecule.)

4. Show the class a plant which has been kept in the dark for a week. Elicit that green plants need sunlight to survive.

5. Check the temperature of your room. Is this the only temperature at which we are comfortable. Elicit that man is comfortable through a wide range of temperatures. Eskimos live in the Arctic where the temperature is often below freezing ($32^{\circ}F$). Many people live in equatorial regions where the temperature seldom goes below $80^{\circ}F$.

   Show pictures of different animals. Ask pupils to describe the environment the animals live in. Arctic animals, such as polar bear, are uncomfortable in warm climates. Tropical animals cannot survive in the Arctic. All living things have a temperature range at which they are most comfortable.

Summary:

If you were going to spend a year in a space ship, what would you have to bring along with you?

Homework:

1. Explain how the food needs of living things differ.

2. Write a short report explaining how the earth is like a space-ship.

Materials:

Aquarium	Thermometer
Green plant kept in darkness	Pictures of various animals

26. HOW DOES THE ENVIRONMENT SUPPLY THE NEEDS OF LIVING THINGS?

Outcomes:

- The atmosphere provides the oxygen necessary for all living things.
- Soil provides the materials needed by plants to grow. Plant eaters, in turn, depend on plants for food.
- Water is provided by rain and melting snow.
- The atmosphere helps prevent wide extremes of temperatures.

Motivation:

Review physical factors of an environment developed in lesson #2 - WHAT MAKES AN ENVIRONMENT. Analyze the needs of land forms and compare to those for an aquatic environment. List needs of all living things on the board. "How does the environment provide these needs?"

Development:

1. Refer back to lesson 12, "What is the composition of the atmosphere?" Elicit that 21% of the atmosphere is oxygen. Living things require oxygen to survive. Pose the question, "How do we obtain oxygen from the air?" Elicit that living things have a variety of ways of breathing in air (lungs, spiracles, gills.) Boil some water to remove the dissolved oxygen. Cover it and let it cool to room temperature. Show the class two beakers, one containing the boiled water and one containing fresh water. Place a goldfish in each beaker. Have the class observe that the fish in the boiled water (lacks air) tries to get air from the surface. It does not act normal. There appears to be rapid gill cover movement. Fish use gills to help them obtain oxygen from the water they swim in. (NOTE: Do not leave the fish in the deoxygenated water for more than two or three minutes.)

2. Demonstrate some seedlings growing in washed sand and other growing in soil. (The plants growing in washed sand do not grow as well as the ones growing in soil.) Soil provides plants with materials for growth. Elicit the names of some animals which depend on plants for food.

3. Show the class a picture of a reservoir or lake. Elicit that this is a source of water for living things. Ask where this water comes from. Rain and melting snow supplies water for reservoirs and other bodies of water.

4. Show pictures of astronauts on the moon. Describe the wide differences of temperature which exist on the moon. Pose the question "Why don't these wide temperature differences exist on the earth?" Explain that the earth's atmosphere filters the light from the sun and also moderates the earth's temperatures.

Summary:

1. How do living things obtain oxygen?

2. Why are fertilizers necessary in areas where soil is poor?

3. Where does our water supply come from?

Homework:

How does the atmosphere help supply the needs of living things?

Materials:

beaker of water boiled and cooled
beaker of fresh water
four goldfish
seedlings in washed sand
seedlings in soil
picture of reservoir or lake
pictures of astronauts on moon.

27. WHAT HAPPENS TO LIVING THINGS WHEN THE ENVIRONMENT CHANGES?

LABORATORY LESSON

Outcomes:

Changes in the environment will affect the survival and behavior of living things.

Motivation:

Ask pupils to describe what they think New York City was like several hundred years ago. Ask what animals they think lived there. Where are these animals now? Why did they disappear? Elicit that as the environment of New York City changed, some animals disappeared.

Development:

1. Encourage pupils to suggest what changes might occur in any environment.

   a. A change in the amount of oxygen in the air.

   b. A change in the yearly rainfall which could lead to a draught or flooding.

   c. A change in the average temperature.

   d. A change in the amount of food available. "What could cause such a change?"

   e. Changes which are caused by pollutants in the air or water.

2. Pose the question "What happens to living things when the environment changes?"

3. Distribute worksheets and material for the laboratory investigation. Guide pupils in preparing and observing the specimens.

Homework:

If New York City's winters became warm and mild, how would that affect us?

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORK SHEET - LESSON 27

Problem: What happens to living things when the environment changes?

Materials:

Daphnia, brine shrimp or tubifex worms. Slides, salt, match, flashlight.

Procedure and Observations:

Use daphnia, brine shrimp or tubifex worms.

1. Place a sample of the material to be studied on a slide and examine it under a magnifying lens. Draw a diagram of what you see in the space on your lab sheet.

2. Place some salt on the slide (so that it dissolves in the water the organisms are in). Examine the slide. What happens?

3. Place another sample on a slide. Gently heat one end of the slide. Examine the organism.

4. Shine a flashlight on one end of the slide. Examine.

5. Can you think of another experiment to test another environmental change which might affect your organisms? (Example: put slide on an icecube.)

Diagram of organisms studied under microscope

Conclusions:

1. The organism used was _____

   They moved (towards, away from)_____the salt.

2. About how long did the organisms live in the salt water?

   _____

3. The organisms moved (toward, away from) _____ the heated end of the slide.

4. Were your organisms able to survive in the heated water?

   _____

5. The organisms moved (toward, away from) _____ the light.

6. How do changes in the environment affect the organisms you studied?

   _____

   _____

28.- HOW DO LIVING THINGS EXCHANGE WATER WITH THE ENVIRONMENT?

Outcomes:

- The life processes of absorption in plants and ingestion in animals take water out of the environment.

- The life processes of transpiration in plants, excretion in animals and respiration in both plants and animals put water back into the environment.

Motivation:

Show the class a plant which has been kept inside a closed plastic bag, in the sunlight, for several days. (A second piece of plastic should cover the soil to prevent evaporation of soil water.) Have pupils note drops of water inside the plastic bag. Elicit that plant gives off water in carrying out life processes. This life process can be identified as transpiration. During this process green plants give off water to the atmosphere.

Development:

1. Ask pupils who have plants at home to describe the care of their plants. Elicit that plants must be supplied with water or they will die.

2. Show the class a plant or a picture of a typical plant. Ask, "Which part of the plant helps it to obtain water?" Elicit that the roots of plants help them to remove water from the soil. This process can be identified as absorption.

3. Discuss the life process of ingestion. Animals take in food and water in order to survive.

4. Place some water on the back of a pupil's hand. Have the pupil blow on it gently. Elicit that perspiration is a means of keeping living things cool in warm weather. Perspiration also adds water vapor to the air. Perspiration and excretion are two processes by which animals get rid of wastes. They both put water back into the environment.

5. Have a pupil exhale on the chalkboard. Lead pupils to identify the damp spot on the chalkboard as water. Respiration is a life process which returns water to the atmosphere.

Summary:

1. Which life processes take water out of the environment?

2. Which life processes put water back into the environment?

Homework:

1. How do plants remove water from the environment? How do they return water to the environment?

2. How do animals remove water from the environment? How do they return water to the environment?

Materials:

Plant left in sunlight in closed plastic bag for several days. Soil should be covered with a second piece of plastic to prevent evaporation of soil water.

Picture or chart of typical plant.

Pictures of animals.

29 - HOW DO LIVING THINGS USE OXYGEN FROM THE AIR?

Outcomes:

- Living things require oxygen for respiration.
- The oxidation of foods in the body provides energy.
- Burning is another form of oxidation.
- Oxidation releases carbon dioxide, water and energy.

Motivation:

Place a peanut in a test tube holder and hold it over a flame until it ignites. Hold the peanut near the chalkboard. Have pupils observe the water left on the board. Place the peanut into the mouth of a bottle containing a small quantity of limewater. Cover the bottle and shake it. Have pupils observe that the limewater turns milky. Explain to pupils that limewater turns milky in the presence of carbon dioxide. Elicit from pupils that the burning peanut gives off water carbon dioxide and heat energy.

Development:

1. Have a pupil breathe on the chalkboard. Have pupils observe the water on the board.
2. Have a pupil blow through a straw into a bottle of limewater. Elicit from pupils that the change in color of the limewater indicates the presence of carbon dioxide.
3. Ask a pupil to check the room temperature, with a thermometer. Take a pupil's temperature with an oral thermometer. Body temperature averages 98.6°F. Have pupils note that body temperature is much higher than room temperature. Pose the question, "Why don't our bodies cool down to room temperature?" Elicit that our bodies produce heat energy to keep our temperatures at 98.6°F.
4. Identify the water, carbon dioxide and heat energy given off by our bodies as products of respiration. Compare these products to those given off by the burning peanut. Explain that respiration and breathing are both forms of oxidation. Oxidation means to combine with oxygen. Oxidation releases water, carbon dioxide and heat energy.
5. Ignite a second peanut. Place it in a pyrex flask. Have pupils observe that the burning peanut goes out. Ignite the peanut again

and place it in the flask. Direct a stream of oxygen, from a rubber tube attached to an oxygen cylinder, into the flask. Have pupils observe that the peanut continues burning. Oxygen is needed for burning. The oxidation of foods by the body requires oxygen. Respiration uses oxygen and releases water, carbon dioxide and heat energy.

Summary:

1. What is oxidation?

2. How are burning and respiration alike?

3. What are the products of respiration?

Homework:

1. What are two forms of oxidation?

2. How do we test for the presence of carbon dioxide?

3. Why do people in cold climates have to take in more food than people in hot climates?

Materials:

Peanuts	Room Thermometers
Test Tube holder	Oral Thermometer
Matches	Pyrex Flask
2 Wide mouth Bottles	Rubber Tubing
Limewater	Oxygen Cylinder
Straw	

NOTE: If oxygen clinders are not available, use a small amount of of fresh sodium peroxide and water to generate oxygen. Observe the precautions given on page 25 of the manual "Science Safety."

30. HOW ARE LIVING THINGS ADAPTED TO THEIR ENVIRONMENT?

Outcomes:

- Each living thing is adapted to survive in a certain environment.
- Adaptations of living things include fur and hair, conservation of water and the ability of leaves to grow toward the sunlight.

Motivation:

Pose the question "How are animals living in the Arctic different from animals living in the Tropics?" Elicit that animals in the Arctic have heavy fur to protect them from the cold while animals in the tropics have light fur or little hair. Lead pupils to understand that tropical animals cannot survive in the Arctic, and Arctic animals cannot survive in the Tropics.

Development:

1. From the motivation, further develop that Arctic animals also have thick layers of fat to protect them from the cold. Examples are seals, walruses and whales. Bring out that these animals are best suited for the Arctic climate. Identify the layer of fat and the heavy hair as adaptations for these animals.

2. Show the class a cactus plant. Ask what type of environment the cactus is best suited for. Explain that the fleshy part of the plant is the stem and the spines are leaves. Ask how these adaptations help the plant survive in a dry climate. Elicit that the stem is adapted for storage of water and the leaves help prevent water loss, since they do not permit extensive transpiration (loss of water).

3. Ask pupils to make a list of animals that live in dry regions. Include the camel, the kangaroo rat, lizards and snakes. How are these animals adapted for the climate they live in? The camel can store large quantities of water to last a long time. The kangaroo rat, lizards and snakes also have means of conserving water.

4. Show pictures of whales or seals. How are they adapted to live in the sea? Elicit that flippers and tails are modified legs which enable them to live in a water environment.

5. Place a geranium plant on a window sill. Note the position of the leaves. Several days later it can be noted that the leaves are facing toward the window. Turn the plant around. How long does it take for the leaves to turn back toward the window? Plants usually grow toward sunlight.

Summary:

1. What adaptations does a polar bear have which enable it to live in the Arctic?

2. How are desert plants adapted to survive in a dry environment?

3. In what type of environment is man best adapted for survival?

Homework:

1. Explain how each of the following animals are adapted to survive in a particular environment.

   a. porpoise

   b. camel

   c. hippopotamus

2. How are the legs of animals adapted to help them survive in different environments?

Materials:

cactus plant

pictures of whales or seals

geranium plant

31. WHY ARE LEAVES GREEN?

Outcomes:

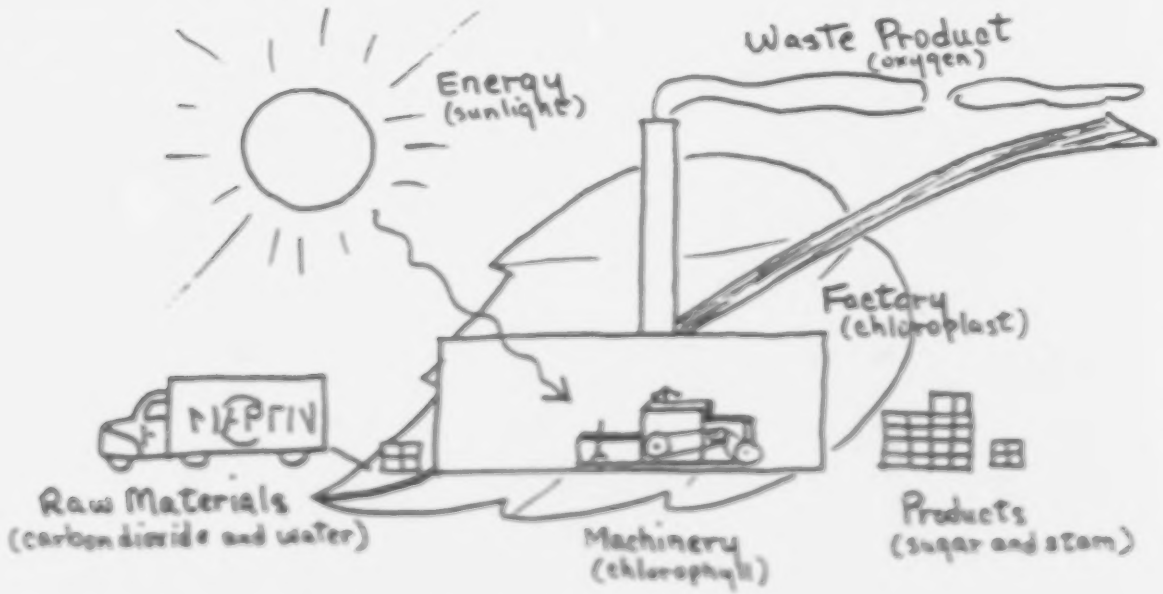
- Green plants are the only living things which have the ability to make their own food.
- Chlorophyll is the chemical which gives leaves their green color.
- Green plants can change carbon dioxide and water into sugar and starch (carbohydrates), in the presence of sunlight and chlorophyll. This process is called photosynthesis.
- During photosynthesis green plants release oxygen into the air. This is used in turn by other living things during respiration.

Motivation:

Direct pupil attention to a green plant. Pose the question, "Where do green plants get food to enable them to survive?" Develop the concept that green plants do not ingest food as other living things do.

Development:

1. Challenge the class to explain how a green leaf is like a food factory. Use the following diagram to elicit your responses.



GREEN LEAF - Food Factory

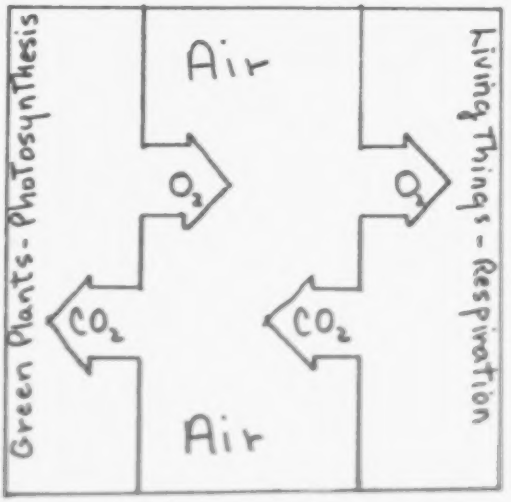
2. Identify the food making process as photosynthesis. Only green plants are able to carry out photosynthesis because only they have chlorophyll. Prepare a wet-mount slide of a section of a green leaf. Project with a microprojector.

   Identify the green bodies in the cells as chloroplasts. Develop the concept that these green bodies contain chlorophyll and it is here where photosynthesis occurs.

3. One of the raw materials needed for photosynthesis is carbon dioxide. Pose the question, "Why don't green plants use up all the carbon dioxide in the atmosphere?" Have pupils recall from the previous lesson that living things release carbon dioxide into the atmosphere during the process of respiration.

   Elicit further that the oxygen released into the air by green plants, during the process of photosynthesis, is used by living things for respiration.

   This process by which oxygen and carbon dioxide are first removed then returned to the atmosphere, is called the "Oxygen-Carbon Dioxide Cycle."



Summary:

1. What is photosynthesis?
2. Why are leaves green?
3. Where does photosynthesis occur?
4. In what ways are green plants beneficial to all living things?

Homework:

1. How is a green leaf like a food factory?
2. What are the raw materials of photosynthesis?
3. What are the end products of photosynthesis?
4. Where do green plants get food?
5. What is the oxygen/carbon dioxide cycle?

Materials:

Green plant

Microprojector

Slides

32. HOW DO LIVING THINGS USE NITROGEN?

Outcomes:

- Nitrogen is necessary for the building of protoplasm.
- Living things obtain nitrogen from the air and soil.
- The nitrogen cycle describes how living things exchange nitrogen with the environment.

Motivation:

Explain that all living things are composed mainly of protoplasm. Living things need protein to build new protoplasm. Protein contains nitrogen. Carbohydrates (sugar and starch) do not contain nitrogen. Pose the question, "Where do green plants get nitrogen to make protein?"

Development:

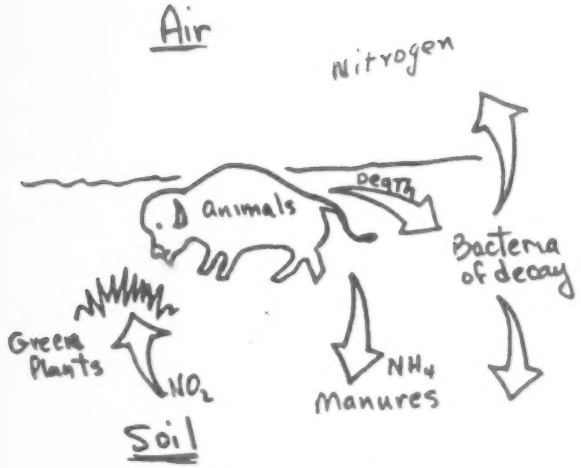
1. Display a package of fertilizer or some sodium or potassium nitrate. Have pupils identify nitrogen as one of the components of these substances. Explain that fertilizers are chemicals containing nitrogen. Elicit that fertilizers are added to soils when little or no nitrogen is present. Lead pupils to the understanding that the roots of plants take in compounds from the soil.

2. Display a leguminous plant or a chart of leguminous plants. Point out the nodules on the roots. Explain that bacteria live in these nodules. The bacteria can take nitrogen from the air and prepare it so that it can be taken in by the roots.

3. Challenge the class to explain how animals get nitrogen (nitrogen compounds) to build protoplasm. Elicit that animals eat plants and/or other animals. They get nitrogen from the protein in the food they eat.

4. Pose the question, "If plants are receiving their nitrogen compounds from the air and soil, why don't they use up our supply of nitrogen?" Elicit that since the nitrogen is not being used up it must be returned to the air and soil somehow.

   Use this chart of the Nitrogen Cycle to demonstrate the interchange of nitrogen between living things and the environment.



The Nitrogen Cycle

Elicit that living things remove nitrogen from the air and soil. The wastes produced by living things and the death and decay of living things return nitrogen to the air and soil.

Summary:

1. Why do living things need nitrogen?
2. Where do plants get nitrogen?
3. Where do animals get nitrogen?
4. What is the nitrogen cycle?

Homework:

1. What do living things need nitrogen for?
2. How is nitrogen returned to the air and soil?
3. How are bacteria useful to other living things?

Materials:

Package of fertilizer or jar of sodium nitrate or potassium nitrate.

Leguminous plant or chart of leguminous plants.

B. INTERRELATIONSHIPS OF LIVING THINGS

33. HOW DO LIVING THINGS GET THEIR FOOD?

Outcomes:

. Living things depend on other living things for food.

. Green plants are the primary source of food for all other living things.

Motivation:

Pose the question, "What do lions eat?" Elicit specific examples of animals lions feed on (zebra, impala, wildebeast and giraffe.) Ask, "What do these animals eat?" Elicit that these animals eat green plants, such as grass, leaves and shrubs. Write the following diagram on the chalkboard:

Lion ⟶ Zebra ⟶ Grass

Identify this as a food chain.

Development:

1. Guide pupils in developing several more food chains.

examples: robin ⟶ worm ⟶ plant materials

bear ⟶ salmon ⟶ minnows ⟶ waterplants

humans ⟶ cow ⟶ grass

Elicit from pupils that all food chains end with green plants. Green plants are the primary source of food for all living things since only green plants can produce their own food.

2. Use the food chain developed in the motivation to identify the following terms:

a. Green plants which produce their own food and are the primary food source of other living things are called PRODUCERS.

b. The animals which feed on plants or other animals are called CONSUMERS.

c. Consumers which eat only plants are called HERBIVORES

d. Consumers which eat only animals are called CARNIVORES

e. Consumers which eat both plants and animals are called OMNIVORES

3. Duplicate the following pictures and have pupils draw arrows to show the many food chains which exist in a community. Identify the finished diagram as a FOOD WEB.(see page 88)

Summary:

1. What is a food chain?

2. Why do food chains always end with a green plant?

3. Why are all consumers dependent upon producers?

Homework:

1. How is a food web different from a food chain?

2. Prepare a chart showing animals which are herbivores, carnivores and omnivores.

Materials:

Duplicated diagram of food web.

Frog

lion

snake

deer

grasshopper

FOOD WEB

owl

rabbit

robin

Trees

grass

vegetables

34. HOW ARE ANIMALS ADAPTED TO OBTAIN THEIR FOOD?

Outcomes:

. Every animal has special adaptations which aid it in obtaining food.

. These adaptations are functional for the specific food the animal eats.

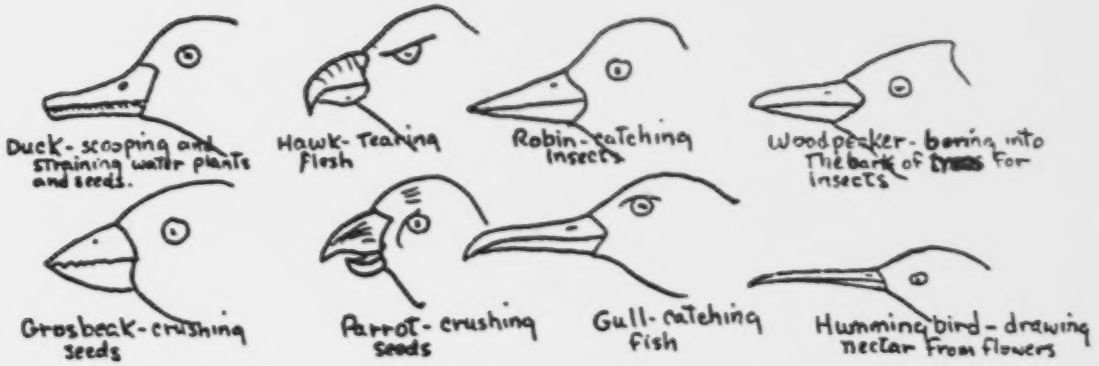
Motivation:

Ask the class to look at their hands and pose the question, "How were the hands of primative man adapted for obtaining food?" Elicit that their hands were adapted for holding and grasping objects. Because of this they were able to use various agricultural tools and hunting implements to obtain food. Elicit that man is one of the few animals that uses tools. The shape of man's hands enable him to do this.

Development:

1. Duplicate the following pictures for the class. Pose the following questions, "How does the shape of the beak indicate the food preferences of each of the birds in the picture? How do each of the following beak types help the bird obtain food? Do any other birds have distinctive beaks or bills?"

   Elicit that the shape of the beak is related to the food the bird eats.


Duck - scooping and straining water plants and seeds.
Hawk - Tearing flesh
Robin - catching insects
Woodpecker - boring into the bark of trees for insects
Grosbeck - crushing seeds
Parrot - crushing seeds
Gull - catching fish
Humming bird - drawing nectar from flowers

2. How do the feet adaptations of birds aid them in their food preferences? Use the following chart to relate the food preferences of birds to their feet or claw adaptations.

Bird	Foot or Claw Adaptation	Food Preference
eagle	clutching claws	fish - small animals
sparrow	perching feet	seeds on bushes and trees
duck	swimming (webbed) feet	water plants
woodpecker	clinging feet	insects under the bark of trees
quail	scratching feet	seeds and insects on the ground
flamingo	wading feet	water plants and animals

3. Birds have other adaptations to aid them in obtaining food. How do the sharp eyes of eagles and hawks help them obtain food? How do the water-proof feathers of the cormorant help it to catch fish under water? Elicit that each bird has special adaptations which aid it in obtaining food.

4. Show the class a chart or picture of teeth. How are the teeth of animals related to the food they eat? Pose the question, "How are the teeth of carnivores different from the teeth of herbivores?" Elicit that carnivores have long pointed canine teeth for tearing flesh and sharp knife edge incisors for cutting. Herbivores have large chisel edged incisors for cutting vegetation and large flat molars for grinding up the coarse vegetation they eat.

Summary:

1. How are birds adapted for obtaining food?

2. What kind of beak and feet would a bird that fed on small animals have?

3. How can the teeth of an animal tell us its food preferences.

Homework:

1. List the food preferences of each of the following birds. How is the shape of each bird's beak related to the food it eats?

chicken	flamingo
swan	toucan
sparrow	whip-poor-will

2. How are the teeth of each of the following animals adapted for the food it eats?

   Beaver, Elephant, Tiger, Squirrel

Materials:

Diagram of the teeth Duplicated pictures of beaks of birds

Enrichment Investigation

An interesting and challenging investigation concerning adaptation may be developed by studying how many birds capture flying insects so easily. Dark lines and dark patches around the eyes of birds were considered to be face markings indicating the sex of a bird or providing protective coloration. Some scientists now suggest that the dark lines serve as sights for tracking and catching flying insects. The dark patches also help to reduce glare around the eye. Encourage pupils to check a standard bird identification reference (library) so as to find out whether there is a correlation between eye markings of insect eaters and what food is obtained. If pictures of birds are available, have pupils trace a line along the dark eye-line toward the beak. Does the line lead to the tip of the beak? Do other living things have such eye markings? (Check pictures of frogs, snakes and fishes.)

35. HOW ARE LIVING THINGS ADAPTED TO PROTECT THEMSELVES?

Outcomes:

. Adaptations help protect animals from predators.

. Some adaptations for protection are: coloration (including mimicry), behavior and special body structures (claws, teeth, legs, nose, ears and eyes.)

Motivation:

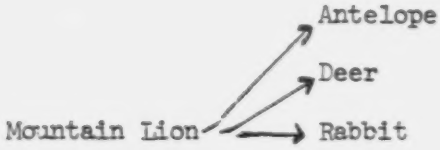
Show the class pictures of animals, such as: porcupine, skunk, deer and bison.

Pose the question, "How do these animals protect themselves from their enemies?"

Elicit that each has its own defense mechanism for protection. The porcupine has sharp quills, the skunk can give off an unpleasant odor, the deer - sharp antlers and hoofs and the ability to run fast, and the bison - sharp horns and great strength.

Development:

1. Show the class the following food web.



Identify the mountain lion as a predator and the other animals as his prey. Ask what adaptations each of the prey animals have for protection. Elicit that each have the ability to run very fast to escape from the mountain lion and each possesses a keen sense of sight and smell.

2. Show the class a flounder. Explain that flounder lie on the ocean floor with the dark side facing up. Pose the question, "How is the flounder protected from predators?" Elicit that flounder blend into sandy and muddy bottoms and so are not easily seen by predators. Identify this as protective coloration.

3. Show the class pictures of monarch and viceroy butterflies. Elicit that they look very similar. Explain that the monarch has a bad taste and is avoided by birds that eat insects. How does this protect the viceroy? Elicit that birds mistake the viceroy for a monarch and reject it also. Identify this as mimicry. The scarlet king snake, which is not poisonous, looks very much like the poisonous coral snake. How does this protect the king snake?

4. Other interesting adaptations for defense are:

. opposum - feigns death

. sloth - a green algae grows on its fur enabling it to blend into the trees on which it lives

. armadillo - covered with tough leathery skin. Can roll into a ball

. turtle - can pull its head and legs into its shell

. squid - squirts out an inky cloud to hide itself

Summary:

1. Which adaptations protect deer from predators?

2. What is the prey of the african lion?

3. Why do many Arctic animals have white fur?

Homework:

1. What is protective coloration? Give three examples.

2. What is mimicry? Give three examples.

Materials:

pictures of animals
flounder - (can be obtained from fish store)
pictures of monarch and viceroy butterflies

SPECIAL NOTE:

The lesson previously described is suggestive only of the very extensive area of protective adaptation. Most Life Science and Biology textbooks will contain units dealing with a variety of forms illustrating how they have adapted to protect themselves.

Where interest level among the pupils is high, the teacher may wish to extend the time devoted to this area.

Suitable activities for further study are:

. A walk around the immediate school neighborhood noting particular features of life forms (birds, dogs, cats, insects which help protect them.

. A visit to an aquarium store or the collecting of pictures to illustrate the variety of coloration of tropical fish.

. Viewing a film or filmstrip, collecting pictures or visiting a zoo to note:

Coloration and broken patterns of animals which enable them to blend with their natural environment

Body structures which help the animal protect itself

. Pupil reports dealing with such areas as:

1. Mimicry
2. Coloration
3. Hibernation
4. Lung-breathing mammals adapting to an aquatic environment (porpoises, seals).
5. Adaptation for running.
6. Seasonal changes in color of fur.
7. Special relationships: remora fish and shark, small fish and sea anemone.
8. Why tropical fish have such a variety of colors.
9. Animals that can change color - chameleon, flounder, octopus
10. The ability of some living things to stay motionless for long periods of time is an adaptive behavior which helps protect the life form - (insects, animals, birds).

. Treasure hunt - hide red and green objects (buttons, construction paper) in a grassy area near the school. Which is easiest to find?

. Have pupils try out various camouflage techniques.

36. HOW DO PLANTS DEPEND ON OTHER LIVING THINGS FOR SURVIVAL?

Outcomes:

. Some plants depend on animals for pollination and seed dispersal.

. Plants depend on other living things to supply carbon dioxide for photosynthesis.

Motivation:

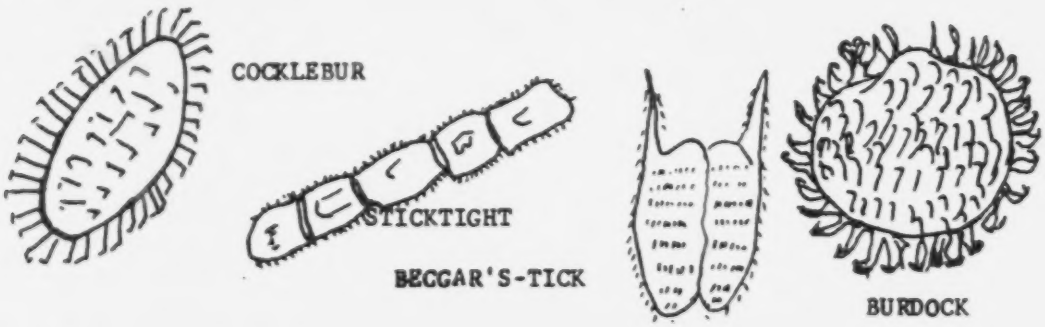
Exhibit a balanced aquarium. Ask pupils to explain how the plants in the aquarium depend on the animals present. Elicit that the animals produce carbon dioxide during respiration. This is used, in turn, by the plants during photosynthesis.

Development:

1. Pose the question, "How are bees beneficial to plants?" Elicit that bees, in their search for nectar, carry pollen from flower to flower. The pollen aids in the production of seeds in the flowers. This is called POLLINATION. Hummingbirds, and some moths and bats also aid plants by pollinating flowers.

2. Display a cherry or raspberry (or other available fruit). Ask pupils to explain where the seeds for these fruits are. Cut each open to expose the seeds. (The berry seeds are on the outside.) Indicate that each seed has a hard thick coat. Challenge the pupils to explain how birds might help to spread these seeds around. Elicit that birds eat the fruit but cannot digest the hard seeds. These seeds are excreted with the bird's wastes. The birds carry the seeds long distances and the wastes act as fertilizer for the growing seed. Identify this as a form of seed dispersal.

3. Show samples of some of the following seeds:



These seeds have tiny hooks and barbs which stick to the hair and fur of animals brushing against them. They are then carried to new places by these animals. This is another form of seed dispersal.

4. Why is the squirrel an important animal in aiding seed dispersal? Elicit that the squirrel stores seeds and nuts by burying them in the ground. He forgets many of these and they later grow into new plants.

5. Discuss the importance of insect-eating birds, such as the woodpecker, the flicker and the sparrow. Elicit that they protect plants from damage by insects.

Summary:

1. How do animals aid in the pollination of plants?

2. How do animals aid in seed dispersal?

3. How does the woodpecker aid in the survival of trees?

Homework:

1. Why are bees important to plants?

2. What are three ways that animals aid in seed dispersal?

Materials:

Balanced aquarium
Cherry or raspberry
Pictures or samples of cocklebur, stick-tight, burdock and beggar tick.

37. WHAT ARE SOME SPECIAL RELATIONSHIPS AMONG LIVING THINGS?

Outcomes:

. Organisms can live together for mutual benefit or for the benefit of only one.

Motivation:

Exhibit a sample or chart of a lichen. Explain that lichens are composed of algae and fungi living together. Identify the algae as a green plant. Pose the question, "How do lichens obtain food?" Elicit that the algae carry out photosynthesis to produce food. Explain that lichens are one of the few plants which can survive in the Arctic. Ask how they obtain food during the long Arctic nights. Elicit that the fungi can also obtain food from other sources and supplies the plant with water. Establish that lichens are actually two organisms which live together for their mutual benefit. Both profit from the relationship. Identify this relationship as MUTUALISM.

Development:

1. Exhibit a picture of a remora and shark or an orchid and a tree. Explain that the remora has a sucker attachment on his head which allows him to attach himself to the shark. The remora is carried by the shark and steals bits of the shark's meals. Orchids attach themselves to other trees for anchorage and support. Elicit that in these relationships only the remora and the orchid benefit. Identify this relationship as COMMENSALISM. Commensalism and mutualism are symbiotic relationships.

2. Discuss other symbiotic relationships. Point out the advantages and disadvantages of each. Do they show mutualism or commensalism?

Exhibit pictures, films or specimens where possible:

a. Rhinoceros and tick bird - The bird eats insects which the rhino flushes from the grass as he moves through it. Tick bird also warns the rhinoceros of danger and protects it from insects.

b. Barnacles and whales - Barnacles attach themselves to the skin of whales and hitch free rides.

c. Sea anemones and damsel fish - Damsel fish receives protection from predators by hiding in the anemone's poisonous tentacles. The anemone receives bits of fish from the damsel fish.

d. Wrasse and grouper - Wrasse cleans grouper of small organisms living on its skin. This serves as food for the wrasse.

e. Intestinal bacteria and man - Man's intestines serve as home for bacteria. They are supplied with food and protection. The bacteria help to digest food and supply man with Vitamin K.

f. Nitrogen fixing bacteria and pea plants - The bacteria are supplied with food and protection. The pea plants get nitrogen and nitrogen compounds from the bacteria.

g. Spanish moss and trees - The Spanish moss get anchorage, support and a greater availability of sunlight.

h. Ants and aphids - The ants use the aphids as we use cattle. The aphids produce a sweet juice called honeydew. The ants collect this for food. The aphids, in turn, are protected by the ants.

Summary:

1. What is mutualism?

2. What is commensalism?

Homework:

1. Explain three examples of mutualism.

2. Explain three examples of commensalism.

Materials:

Pictures or films illustrating symbiotic relationships, lichen, Spanish moss, leguminous plant.

C. HOSTS AND PARASITES

38. IN WHAT WAYS CAN LIVING THINGS ACT AS AN ENVIRONMENT?

Outcomes:

. Organisms can serve as an environment for other living things.

. Organisms which are harmful to the hosts they live on are called parasites.

Motivation:

Ask pupils who have pet dogs to discuss how their dog may serve as an environment. Elicit that the dog may have fleas or ticks on its fur and skin. The dog may also have worms in its intestines. Point out that these organisms live on the dog and that the dog is a source of food for them. Identify these organisms as PARASITES. Parasites live on or inside other organisms.

Development:

1. Define a parasite as an organism which lives on or in another organism and is harmful to it. Identify the organism that the parasite live on as a HOST.

2. Show slides of fleas and lice. Call attention to the sucking mouth parts. These are used to extract blood from the host. In addition, point out the structural adaptations of the parasites to clinging or burrowing on their host.

3. Show slides or a chart of a tapeworm. Elicit that the worm lives in the intestines of animals and absorbs food from the digestive system of its host.

4. Explain that some wasps begin their lives as parasites. They lay eggs in the bodies of other insects (spiders, caterpillars). When the eggs hatch the larvae live off the host.

5. Exhibit a chart or picture showing some parasites of man.

Discuss some of the following parasites of man:

- Worms: tapeworm, pinworm (roundworms), fluke, hookworm.
- Microorganisms: organisms causing malaria, sleeping sickness.
- Insects: lice, fleas, mites

Summary:

1. What is the difference between parasitism and commensalism?
2. What is a host?

Homework:

1. Wasps are parasites on other insects. Why are wasp helpful to man?
2. Name three parasites which live on other organisms.
3. Name three parasites which live inside other organisms.

Materials:

Microscope or microprojector; prepared slides of fleas, lice, tapeworm; chart of parasites; micro-slide viewer and photomicrograph sets #74, 75.

39. WHAT ARE SOME CAUSES OF DISEASE IN MAN?

Outcomes:

. Diseases affect man by interfering with normal body functions.

. Diseases in man are caused by germs, poor diet, organ degeneration, allergic reactions, inheritance and environmental factors.

Motivation:

Have pupils recall illnesses suffered by family or friends over the past year. List these on the board. Challenge the pupils to categorize the various diseases listed. Categories should include germ diseases, dietary deficiencies, degeneration, organic and environmental disorders.

Development:

1. Exhibit a chart of disease causing organisms. Explain that disease-causing organisms may be animals or plants.

   Identify some diseases caused by plants:
   . bacteria (pneumonia, strep throat, tuberculosis)
   . fungi (athlete's foot, ringworm)

   Identify some diseases caused by animal forms:
   . protozoans (malaria, sleeping sickness)

   Identify viruses as organisms which are neither animals or plants. List some diseases they cause:
   . viruses (measles, chicken pox, polio, common cold)

2. Point out that many diseases are caused by dietary (mineral, nutrient or vitamin) deficiencies: scurvy, rickets, malnutrition, anemia.

3. Explain that sometimes organs in our body degenerate with age, through hereditary factors or through other complex causes. Diseases due to these factors include:

heart disease	sickle cell anemia
diabetes	hardening of blood vessels
stroke	hemophilia

4. Environmental factors such as pollution, poor sanitation, smoking and poisons can lead to many illnesses, such as: cancer, emphysema, dysentary and circulatory disorders.

Summary:

1. What are some causes of disease in man?

2. What are some disease causing organisms?

Homework:

1. What are some diseases caused by bacteria?

2. What are some diseases caused by protozoans?

3. What are some diseases caused by viruses?

Materials:

Chart of disease-causing organisms.

40. WHAT ARE SOME PLANTS AND ANIMALS THAT CAUSE DISEASE?

LABORATORY LESSON

Outcomes:

. Bacteria and fungi are plants which sometimes cause disease in man. (Many bacteria and fungi are harmless to man.)

. Protozoa and worms are some animals which can cause disease in man.

Motivation:

A day or two prior to this lesson, innoculate several petri dishes containing agar with bacteria or mold obtained from dust, dirt, soil or stagnent water. Exhibit these to the class. Be careful to see that they are kept closed. Point out the bacterial colonies on the agar. Elicit that each colony started from a small number of bacteria and now contains many millions of organisms. Relate this to the growth of bacteria in our bodies. Indicate that even though bacteria can cause disease many bacteria are not harmful to man and many are helpful. Bacteria are useful in the production of alcoholic beverages and cheese and in the tanning of leather.

Development:

1. In this lesson, pupils will have an opportunity to observe for the first time organisms which cause diseases in man.

2. Prepared microscope slides of bacteria, protozoans and parasites may be obtained by referring to the Approved List of Science Supplies for the appropriate vendors.

3. In addition, National Teaching Aids (also on the Approved List) has available the Micro-Slide Viewer and Photomicrograph Sets which include:
   #20 Harmful Bacteria
   #74 Parasitism - A Way of Life
   #75 Animal Parasites of Man (Trichina, Hookworm, Malaria, Tapeworm, Tick)
   #82 Non Green Plants - Heterotrophic Nutrition

4. The lesson is designed to introduce pupils to the world of disease-causing organisms. Avoid esoteric science terminology and intensive in depth study of this area.

5. Distribute worksheets and material for this laboratory investigation. Guide pupils in observing and drawing the specimens.

Materials:

Prepared Microscope Slides - Types of Bacteria
- Protozoans - Sleeping Sickness
- Malaria
- Parasite Worms, Ticks
- Molds, Fungi

or

Micro-Slide Viewer and Photomicrographs
#20 Harmful Bacteria
#74 Parasitism
#75 Animal Parasites of Man (Trichina, Hookworm, Malaria, Tapeworm, Tick)
#82 Non-Green Plants

Yeast Suspension
Slides
Coverslips
Medicine dropper
Lens paper
Microscopes

Homework:

How are different disease-causing organisms transmitted?

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON 40

Problem: What are some plants and animals that cause disease?

Materials:

Microscope, prepared slides of bacteria, yeast suspension, slides, coverskips, lens paper, medicine dropper, prepared slide of Trypanasome, tapeworm and/or pinworm.

Procedure and Observations:

1. Examine the slides of bacteria under the microscope. There are three kinds of bacteria. Cocci are round, spirilla are corkscrew shaped and bacilli are rod shaped. These are plants which cause disease in man. Can you identify each of these three kinds of bacteria? Draw a diagram of each in the space on your lab sheet.

2. Place a drop of the yeast suspension on a clean slide. Yeast is an example of a non-green plant. Carefully place a coverslip over the yeast. Examine the slide under the microscope. Draw a diagram of what you see in the space on the lab sheet.

3. Your teacher will give you other slides which show animal organisms that cause disease. On your labsheet below, draw what you see through your microscope. Be sure to label the picture with the name of the organism.

Diagrams of Organisms Seen Under Microscope

1.	1.	1.
cocci	bacilli	spirilla
2.	3.	
yeast		

Conclusions:

1. The three types of bacteria studies are:

   _____, _____, _____.

2. Yeast is (a plant, an animal).

3. An example of an animal that causes disease in man is _____
   _____.

4. When bacteria are allowed to reproduce on agar they form _____
   _____.

5. Most bacteria are (harmful, not harmful) to man.

6. Some bacteria are useful in the production of _____.

41. HOW DOES THE BODY PROTECT ITSELF AGAINST DISEASE CAUSING ORGANISMS?

Outcomes:

- Germs may enter the body through the mouth in the food and water we ingest, through the nose in the air we breathe and through breaks in the skin.
- The body's defenses against germs include the skin, white blood cells, stomach acid, mucous linings and cilia hairs in the respiratory system.

Motivation:

Pose the question, "How can germs enter your body?" Elicit that germs may enter in the food we eat or the water we drink. We may inhale germs in the air we breathe. Germs also can enter the body through breaks in the skin. Ask the class to explain how the body protects itself against germs that may enter it.

Development:

1. Show the class a chart of the blood or the circulatory system. Point out the white blood cells. Explain that they engulf germs which may enter the body and destroy them. Elicit that the blood contains chemicals called antibodies which also fight against germs which may enter the body.

2. Point out that the stomach contains a very strong acid. Ask how this acid protects the body from germs. Elicit that the acid destroys some of the germs which enter the body in the food we eat and the water we drink.

3. Show the class a cross sectional model of the skin. Point out the tough outer layer of the skin. Elicit that the skin is a waterproof and germproof covering for the body. Pose the question, "How might germs sometimes enter the body through the skin?" Elicit that cuts, scratches and wounds permit germs to enter the body. Ask what line of defense the body uses against these germs. Bring out that the blood is the body's second line of defense against these germs.

4. Explain the body's defenses against germs which enter in the air we breathe. The passages in the nose and throat are lined with cells which produce a sticky mucous secretion and which have tiny hairs, called cilia. They project into the respiratory passage. The hairs are in constant motion and create currents which sweep germs onto the mucous. The mucous traps these germs in its sticky grasp and chemicals in the mucous destroy them.

Summary:

1. What are the body's first lines of defense against germs?

2. Why is the blood called the body's second line of defense?

Homework:

1. How may germs enter the body?

2. How does the body fight germs that enter with the food we eat?

3. How does the body fight germs that enter with the air we breathe?

4. Why should cuts and scratches be treated with antiseptics and covered with a dressing.

Materials:

Chart of blood or of circulatory system.

Cross sectional model of the skin.

42. WHAT IS A COMMUNITY?

Outcomes:

- A population is a group of similiar (the same species) organisms found in a particular place.
- A community consists of all the organisms (populations) in a particular place.
- An ecosystem consists of all the living and non-living things in a particular place that interact with one another.
- A biome is a distinctive community characterized by a specific climate.

Motivation:

Exhibit an aquarium and a terrarium. (Pictures of the Serengeti and other game preserves can also be used). Identify these as ECOSYSTEMS. Pose the question, "What is each ecosystem composed of?" Elicit the various living and non living components of each and list these on the chalkboard. Define an ecosystem as all the living and non-living things in a particular place that interact with one another.

Development:

1. Refer to materials used in motivation. Are each of the ecosystems the same? In what ways are they different? Stress the fact that water is an important part of the aquarium ecosystem since the fish get oxygen from it. Sunlight is an important part of the terrarium since the green plants need it for photosynthesis.

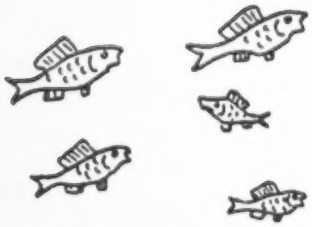
2. Discuss the fact that ecosystems can be large or small. The aquarium is a small ecosystem. A lake is a large ecosystem. A rock may cover a very small ecosystem in the soil, whereas the African Plains are a very large ecosystem. A single tree can be considered an ecosystem since many organisms can be found living in and on the tree. A dog whose fur may contain fleas or ticks can also be considered an ecosystem.

3. Define a community as all the living things in a particular place. List the organisms in each of the communities you have been studying in class. Encourage pupils to use the term "SPECIES" when referring to similiar organisms.

4. Define a population as a group of similiar organisms in a community. Identify the population in each of the communities you are studying.

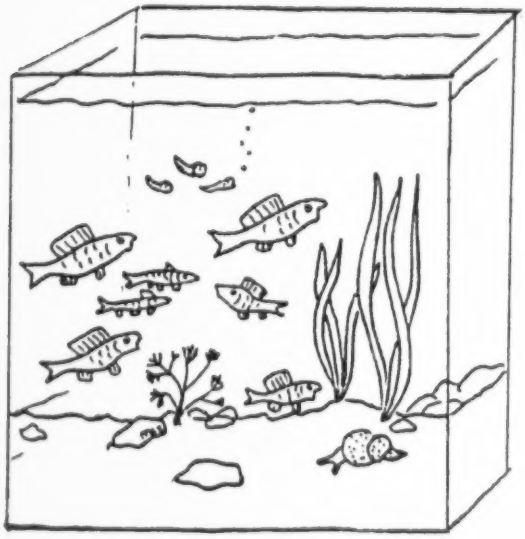
5. Reproduce and distribute the following diagram to illustrate the relationships among organisms, populations, communities and ecosystems. Identify living and non-living parts.

organism



Population

Community



Ecosystem

6. Define a biome as a particular type of ecosystem characterized by a specific climate.

   Examples are:
   1. The coniferous forest biome
   2. The deciduous forest biome
   3. The grassland biome
   4. The desert biome
   5. The tropical rain forest biome
   6. The tundra biome

Summary:

1. What is an ecosystem?

2. What is a community?

3. What is meant by the term population?

4. Describe a particular biome.

Homework:

Examine an ecosystem. It can be an aquarium, a yard, a small plot of land, a tree standing in the street, a park, or any other ecosystem available.

1. List the organisms in the community.

2. Which organisms have the largest population?

   Which have the smallest?

3. Are there any organisms you cannot see?

4. How do some of the organisms interact with the non-living things in the ecosystem?

Materials:

aquarium terrarium pictures of game preserves

43. WHAT FACTORS AFFECT POPULATIONS IN A COMMUNITY?

Outcomes:

- Factors in the environment, such as food, water, sunlight, available space affect populations in a community.
- The place an organism lives is called its habitat.
- The role an organism plays in the community is called its niche.

Motivation:

Carry out a discussion of the energy needs of communities. Use the following passage to initiate the discussion.
All the energy needed by living things comes from sunlight. Green plants are the only living things which can take the energy directly from sunlight. They store the energy in the form of carbohydrates. When a herbivore eats a green plant it takes this stored energy into its body. Carnivores take the stored energy from herbivores into their bodies. The amount of energy passed on gets less and less. It's like passing an ice cube from person to person. The ice cube grows smaller as it is passed along. The energy gets less and less because each organism uses some of the energy before it is passed on.

Development:

1. Have pupils utilize the story in the motivation to answer the following questions.
   a. How does energy from sunlight enter the ecosystem?
   b. How is energy distributed through a community?
   c. Why are there more producers than consumers in a community?
   d. Why are there more herbivores than carnivores in a community? Elicit the concept that there is an energy pyramid starting with producers and ending with carnivores in every community.

There are always more producers than consumers and more herbivores than carnivores.

2. Every organism in a community has a place, where it lives, and a job. The place an organism lives is called its habitat. The habitat of most animals is determined by available food and shelter. The job an organism does is called its niche. Both moles and prarie dogs live in tunnels burrowed under the ground. They share the same habitat. Moles are carnivores. They eat worms and insects. Prarie dogs are herbivores. They live on grass and seeds. They have different jobs in the community. They each have a different niche.

3. Pose the question, "How does the amount of available food and shelter affect a population?" Elicit that the more organisms in a population the greater the food needs and the fewer the available habitats or places of shelter. This causes competition and the weaker animals do not survive. This in turn reduces the size of the population making more food and shelter available.

4. Select other living forms. Have pupils identify the habitat and niche for each.

Summary:

1. What is an animal's habitat?

2. What is an animal's niche?

3. What happens to a population when the amount of available food is decreased?

Homework:

1. What is the niche and habitat of each of the following animals?

   a. lion
   b. deer
   c. ant
   d. crow
   e. cow
   f. seal
   g. whale
   h. shark
   i. rabbit
   j. squirrel

44. HOW DO INTERACTIONS IN A COMMUNITY AFFECT POPULATIONS?

Outcomes:

. Changes in one population affect other populations in a community.

. Two different organisms cannot occupy the same niche and habitat in a community.

. The interaction of living things in a community is called the balance of nature.

. Man's interference with the balance of nature can upset the ecosystem.

Motivation:

Pose the question, "How can the reduction in a deer population affect the population of mountain lions?" Elicit that as the deer population decreases, there is less food for the mountain lions. This results in competition for food. The weaker and older individuals do not survive.

Ask pupils how man's hunting of mountain lions has affected the population of deer. Elicit that lions also have an important niche in the community. They keep the deer population down by preying upon the weaker individuals. Without lions the deer population will increase and cause famine, since there will not be enough available food for them.

Development:

1. In any community members of any one population all occupy the same niche and habitat. The amount of available food and shelter is limited. This limits the size of the population in the community. Ask pupils to define the term "overcrowding". Elicit that overcrowding means that there is not sufficient food or space for each individual in the community. Pose the question, "How do animals in a community react to overcrowding?" Lead pupils to understand that overcrowding can lead to competition for available food and space. This can lead to fighting among members of the community, starvation for those members which cannot complete effectively with others and the migration of members of the community to other areas where there is less competition.

2. Challenge pupils to explain the following statement, "Two different organisms cannot occupy the same niche and habitat in a community." Lead pupils to understand that when two different organisms occupy the same niche and habitat it leads to competition between them. The organism which is most successful will crowd out the other. The big game herds of herbivores on the African Plains contain many different kinds of animals. Even though they all occupy the same habitat, thereis no competition between them. Each type of animal eats a different type of plant material so there is enough food for all.

3. All the members of a community interact with one another. This interaction is called the balance of nature. When man interferes with the balance of nature he can upset the environment.

   Some examples of this are:

   a. The overpopulation of rabbits in Australia: Man introduced rabbits into Australia. There were few predators to control the population and the rabbits had little competition for food and shelter. The rabbits are now destroying farm crops.

   b. Starvation of the New York State deer herds: Man has eliminated most of the large predators from the state. The lumber industry has reduced most of the food and shelter in the state. The deer herds have grown too large for all individuals to find adequate food and shelter.

   c. Pollution of The Great Lakes: Pollution has destroyed much of the life in The Great Lakes by reducing available food and habitat.

Summary:

1. What is meant by the balance of nature?

2. Why are lions important to the deer community?

3. Why have rabbits multiplied so fast in Australia?

45. HOW DO COMMUNITIES CHANGE?

Outcomes:

. Succession is an orderly process by which one community is replaced by another.

. A climax community is a stable one for the environment.

. Man causes changes that prevent natural successions or climaxes.

Motivation:

Ask pupils to describe changes they have noticed in recently cleared lots, untended parks, gardens or abandoned farms. Elicit that first weeds take over, then shrubs crowd out the weeds. Finally, trees may appear. Identify this as succession.

Development:

1. Illustrate the probable stages succession will take in a bare field.

Bare Land → Lichens, Mosses and Ferns → Grass and Weeds → Shrubs → Pine Forest → Oak-Hickory Forest

Identify the final stage as a climax community.

2. Describe each of the above stages in succession.

a. Lichens, mosses and ferns can grow in poor soil and get their start from spores carried by air.

b. Grasses and weed grow quickly in open sunlight with limited water and produce many seeds.

c. Shrubs push up slowly through the weeds. They grow slowly but survive year to year. The soil has become richer due to the plant remains from the grasses and weeds. When the shrubs become large enough they shade out the weeds. The weeds will then disappear.

d. Pine trees grow in the now rich soil shaded by the shrubs. The pine trees take a long time to grow but soon shade out the shrubs beneath them.

e. The floor of the pine forest presents ideal conditions for the growth of oak and hickory trees. The pine forest develops into an oak-hickory climax community. The whole process has taken from 150 to 200 years.

As the plant community changes, so do the animals which inhabit it.

3. Man causes changes which prevent natural successions and climaxes.

   Some examples of this are:

   a. Ragweed is one of the first plants to appear on bare roadsides. Ragweed also causes hay fever. Ragweed elimination teams destroy ragweek with fire and chemicals. This prevents the next community from getting established and the ragweed returns the next year more abundant than ever.

   b. Strip mining destroys the physical environment so that succession is not able to begin.

Summary:

1. What is succession?

2. What is a climax community?

Homework:

1. List the stages in succession of an abandoned farm.

2. How may man interfere with succession?

3. Why are weeds the first arrivals on the bare roadsides?

III ENERGY IN THE ENVIRONMENT

A. THE SUN SUPPLIES ENERGY FOR THE EARTH

46. WHERE DOES OUR ENERGY COME FROM?

Outcomes:

- Most of the earth's energy comes from the sun.

Motivation:

Invite a number of pupils to volunteer as observers for the class. Asking the question, "How may a thermometer be used to show the energy in sunlight?", direct some of the volunteers to hold their thermometers in sunlight (or other strong artificial light source) while others will hold their thermometers in the shade. At frequent intervals have each call out the temperature reading. Conclude that the sunlight caused the temperature to rise.

Development:

1. Ignite a piece of paper by focusing the sun's rays on it. Prepare the paper by drawing a black spot on it with a lead pencil. Place the paper on an asbestos square. Focus the sunlight with a strong hand lens. Elicit that the energy brought to the earth by sunlight becomes heat energy.

2. Set a radiometer (an instrument sensitive to solar radiation) in direct sunlight (or an artificial light source.) Pupils observe the rapid rotation of the blades. Place an opaque paper between the radiometer and the light source. Pupils observe the effect on the radiometer by blocking the sun's light. Place a square of clean glass between the radiometer and the sunlight or light source. "Does the glass affect the turning of the radiometer blades?" Identify sunlight as radiant energy and guide pupils to conclude that the radiant energy is changed to heat energy when it strikes an opaque substance.

3. Prepare two similar glass culture dishes or small glass beakers in advance. Fill one with dark earth and the other with water. Let them stand until they reach room temperature. At the appropriate time during class, have pupils hold thermometers just underneath the surface of the earth and the water. At various intervals, have the pupils announce the temperatures. Guide the pupils to conclude that the radiant energy passed through the water and was not changed to heat as was the case with the dish containing earth.

4. On a cloudy day place a thermometer on a window sill where the sun would normally shine. Hold a hand lens in such a way that the sunlight available can be focused on the thermometer.

Observe how much the temperature can be made to rise. Elicit that this rise in temperature indicates that some sunlight passes through the clouds providing the earth with energy. (Discuss this portion if proper conditions do not exist in the room.)

5. Have pupils set up blueprint paper to record an image. This activity is started at the beginning of the period and the results are observed towards the end of the period. Instruct the pupils to place a small opaque object on the blue side of the paper. Towards the end of the period the object is removed. Ask "What changes took place on the blueprint paper?" Pupils conclude that the energy of the sun's light changed the exposed portion of the blueprint paper.

Summary:

1. Why is very little fuel needed to heat houses in the tropics?

2. Why could you receive a sunburn on a cloudy day at the beach?

3. Why do you try to keep colored clothes out of direct sunlight?

Homework:

1. Take an empty glass soda bottle and fit a rubber balloon over the mouth of the bottle. Expose the bottle to direct sunlight. Before fitting the balloon onto the bottle blow up the balloon several times to stretch it.

   A. Where did the energy come from to inflate the balloon?

   B. How would another soda bottle fitted with a balloon and placed in the shade help to prove your answer in part A?

2. Why do the blades of a radiometer spin when the radiometer is taken out of doors on a cloudy day?

Materials:

Radiometer
Two thermometers
Asbestos pad
Hand lens
Blueprint paper
Light bulbs in wired sockets (for use on cloudy days)

47. HOW DOES THE ATMOSPHERE AFFECT THE AMOUNT OF LIGHT REACHING THE EARTH?

LABORATORY LESSON

Outcomes:

- Not all of the sun's light reaches the earth.
- Materials in the atmosphere decrease the amount of sunlight reaching the earth.

  A radiometer is an instrument which can detect certain parts of the sunlight spectrum.

Background:

The radiometer used in this lesson measures the intensity of infrared radiation. The blades will turn faster when there are more infrared rays striking the radiometer. The black colored sides of the blades absorb more infrared rays than the silver colored sides. The air molecules are heated more near the black surfaced blades. Increased movement of the air molecules causes the black side of the blade to be pushed more strongly than the silver side. The net result is a spin of black vanes away from the light source.

There is a partial vacuum inside the radiometer; therefore, there is less resistance to the movement of the blades.

Motivation:

Expose a radiometer to direct sunlight. Ask pupils to describe what they see. Draw the window shade. "Why do the blades stop spinning?" Ask pupils to compare the rate of spin of the blades on a sunny and a cloudy day.

Development:

1. Distribute worksheets and materials to each group of pupils.
2. Show how a radiometer responds to an artificial light source.
3. Instruct pupils how to count the number of spins of a single blade by focusing attention on one blade.
4. Show pupils how to simulate an increase in materials in the atmosphere. These materials filter, absorb or disperse some sunlight. Place a 250 m/ beaker in front of the lamp. The radiometer is placed on the other side of the beaker.

5. Demonstrate how to use the graduate cylinder to add specific amounts of methylene blue to the water.

   NOTE: Be sure that the water is clear and free of bubbles. The radiometer must be motionless in the normal lighting in the room.

   Draw some shades and turn out some overhead lights if necessary. Before each count of spins of the blade is made, the blades must be motionless. (Have on hand some shoeboxes in which to place the radiometers if there is too much light in the room).

Materials:

Radiometer	10 milliliter graduate cylinder
250 milliliter beaker	microscope substage lamp (or 25 watt, light bulb)
Glass stirring rod	Methylene blue solution

Homework:

1. Why do you usually feel cooler on a warm cloudy summer day than on a sunny summer day?

2. How might an increase in pollutants in the air in New York City affect the amount of sunlight striking the City?

3. How can the moisture in the atmosphere keep some sunlight from reaching the earth?

(Duplicate for Use by Pupils)

LABORATORY WORKSHEET - LESSON 47

Problem:

What happens to some of the sun's light when it passes through the atmosphere?

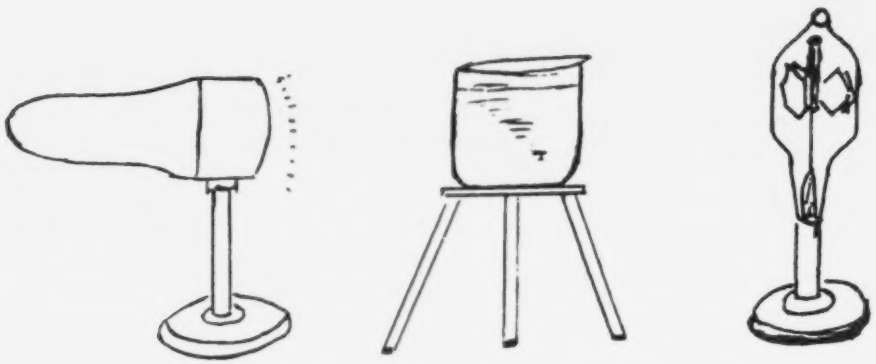
Materials:

Radiometer	10 milliliter graduate cylinder
250 milliliter beaker	microscope substage lamp
glass stirring rod	methylene blue solution

Procedure and Observations:

1. Examine the radiometer. Be sure that the blades are motionless. If the blades are moving, inform your teacher. You may have to shield the radiometer from the light in the room by placing the radiometer in the bottom part of a shoe box standing on its short side.

2. Set up the materials as shown in the diagram below:



3. Turn on the lamp and watch the blades spin. Practice counting the number of spins one of the blades makes in 20 seconds. Turn off the lamp.

4. Add cold water to the beaker up to one-half inch under the rim. Be sure that the beaker is raised high enough so that the rim is above the top of the radiometer.

5. When the water is clear of bubbles turn on the lamp. Wait until there is a steady spin. The number of complete spins one blade makes in 20 seconds is _____. Turn off the lamp.

6. Add 1 milliliter of methylene blue to the water. Stir gently. Be sure that the water is still and free of bubbles. The blades must be motionless before the lamp is turned on. The number of complete spins one blade now makes in 20 seconds is _____.

7. Add another milliliter of methylene blue to the water and stir. Turn on the lamp. The number of complete spins one blade makes in 20 seconds is _____.

8. Add 2 milliliters more of methylene blue to the water. Follow instructions outlined in step 6. The number of complete spins one blade makes in 20 seconds is _____.

9. Record your data in the following chart:

Amount of Metylene Blue in the Water	Number of Spins in 20 Seconds
0 milliliter	
1 milliliter	
2 milliliters	
4 milliliters	

Conclusions:

1. With which amount of methylene blue do the blades of the radiometer make the least number of complete spins?

2. Which amount of methylene blue allows most of the light to pass through?

3. Why is clear water used in this investigation?

4. On Monday the atmosphere is clear. On Tuesday there are clouds in atmosphere. On Wednesday there are many pollutants in the atmosphere. When will the least amount of sunlight reach the earth? When will the greatest amount of sunlight reach the earth?

48. WHAT ARE THE COLORS OF SUNLIGHT?

Outcomes:

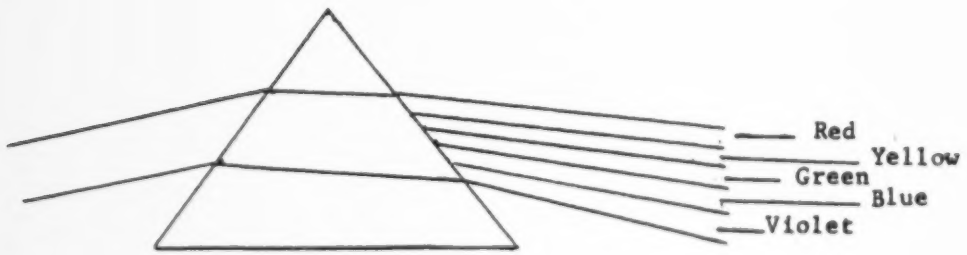
- Sunlight is composed of several colors
- A prism is used to show the different colors that make up sunlight
- The colors in a spectrum of white light (or sunlight) are always grouped in the same order

Motivation:

Dim the room. Place a prism in a narrow beam of sunlight. Hold the prism by its long axis in the vertical position and rotate the prism (several spectra will sweep across the walls of the room.) Now rotate the prism on its long axis but hold the long axis in a horizontal position. (spectra will sweep across the ceiling.) What colors can be identified?

Development:

1. Demonstrate the light spectrum on a white screen. Cut out a circle of opaque paper, make a hole in the center and tape the paper to the rim of the lens of a filmstrip projector. Place a glass prism in the path of the narrow beam of light.



2. Have the pupils name and record the colors of the spectrum seen on the screen.

3. Show pictures and/or transparencies of the rainbow. Elicit from the pupils the resemblance of the white light spectrum and the sunlight spectrum as seen in the rainbow. Pupils should be helped to see the similarity between a glass prism and drops of water in the atmosphere in producing these spectra. Guide the pupils to conclude that sunlight is composed of several colors. Point out that the spectra of white light and sunlight are always grouped in the same order.

Summary:

1. How do drops of water in the atmosphere sometimes help to remind us that sunlight is made up of different colors?

2. How do some sunsets show that sunlight is not just one kind of color?

Homework:

1. Choose one of the following activities and record your observations:

   A. Look across the grooves in a 12 inch phonograph record held toward the light.

   B. Use a straw to blow some soap bubbles into the sunlight. Let the bubbles float into the sunlight.

   C. Spread a thin film of oil on water. View this thin film of oil in sunlight.

2. Use crayons or colored pencils to draw the colors of the sunlight spectrum.

Materials:

Prism Light source opaque paper

49. IN WHAT LIGHT DO GREEN PLANTS GROW TALLER?

LABORATORY LESSON

PART A (Two sessions required - one week apart)

ADVANCE PREPARATION

The investigations suggested below must be prepared at least 7-9 school days in advance of this laboratory activity. Pupils will be involved in preparing the set up, making daily observations, watering and making initial and final measurements.

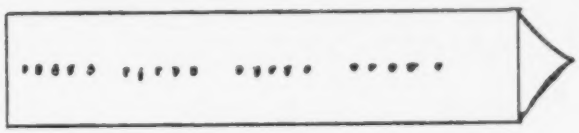
Materials:

5 - 1 Quart Milk containers
Radish seeds (100)
Garden soil

Procedures:

1. Remove 1 long side of the container.
2. Seal the open end.
3. Fill the container to the 1/3 level with soil.
4. In each container, set up 4 areas of 5 seeds.

Top View



5. Water the soil so that it is damp. Have pupils check soil daily.
6. Place container in direct source of light (artificial or sunlight.)
7. Prepare 5 quart containers for 5 groups of pupils.

Outcomes:

. Green plants need light in order to grow.

. Green plants grow taller in the red part of the sunlight spectrum.

Motivation:

By means of appropriate questions, review the physical factors which affect the growth of green plants. Elicit that sunlight

is very important for green plant growth. "Do green plants need all parts of the sunlight spectrum?" "What could you do with these green radish seedlings to see if green plants need all or part of the sunlight spectrum?

Development:

1. Distribute worksheets and materials to each group of pupils.

2. Guide the pupils in constructing a windowed cover for the seedlings as directed in the laboratory worksheet (see diagram).

3. Review and demonstrate techniques for making observations (general appearance of plant, vigor of stem and leaves, color) and measurements:

   Ruler - plant size (use both metric and inches).

   Graduate cylinder - measuring uniform quantities of water.

4. Practice finding the average of a series of numbers.

5. Inform pupils that their setups will be maintained by them for a week. All setups must be given the same physical conditions: Water, air, temperature and exposure to sunlight (or an artificial light source).

Materials

Construction paper	5 milk containers with radish seedlings
Pieces of cellophane: clear	10-6 inch rulers
red, blue, yellow	5-25 ml. graduate cylinders
Scissors	

Homework:

1. Describe the control in your investigation.

2. Why are you giving all the seedlings in your investigation similar physical conditions (temperature, water, air)?

3. State one possible result you expect to see in this investigation.

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET LESSON 49

Problem: In what light do green plants (radish) grow taller?

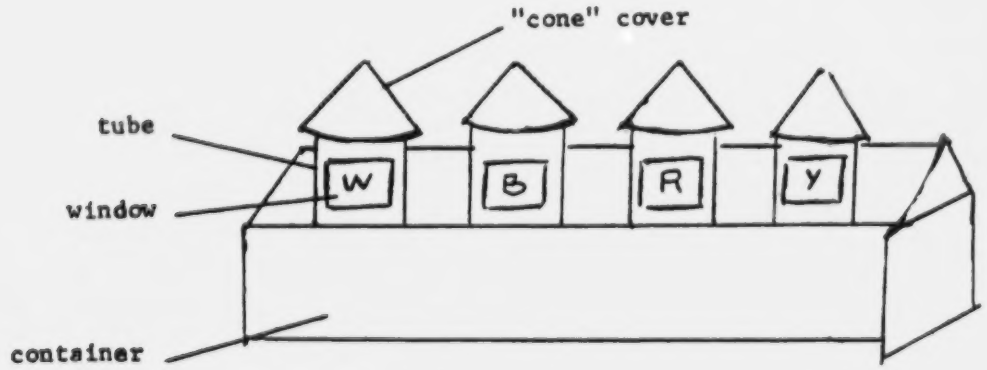
Materials:

One milk container with radish seedlings
Two - 6 inch rulers
25 ml graduate cylinder
Scissors
Tape
Construction paper
Cellophane: clear, red, blue, yellow

Procedures and Observations:

1. You have received a container with four sets of five seedlings. Since sunlight is a mixture of different colors, you will find out which color helps plants grow best.

   Two pupils in the group prepare the four covers for the radish seedlings with construction paper. Make a tube with the construction paper which is wide enough for each area of seedlings. Then make a cone to cover the opening of each tube. Cut out a window in the tube portion. Be sure that all radish seedlings can be seen through the window. Cover the window on each cover with a different color of cellophane (use glue or tape).



2. While the covers are being prepared, other pupils will examine the plants and record their observations. Your teacher will tell you what things to note.

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3. Determine the height of each seedling. Record the heights in the chart.

SEEDLING GROUP	HEIGHT OF EACH SEEDLING	AVERAGE GROUP HEIGHT
White light	1.___ 2.___ 3.___ 4.___ 5.___	_____
Blue light	1.___ 2.___ 3.___ 4.___ 5.___	_____
Red light	1.___ 2.___ 3.___ 4.___ 5.___	_____
Yellow light	1.___ 2.___ 3.___ 4.___ 5.___	_____

4. Water each container when necessary. Check the soil each time you come to the science classroom. Keep the soil damp.

5. After you examine the seedlings, be sure to cover each area of seedlings with the same cover.

6. Place the container with the cellophane windows facing a direct light source (sunlight may be used) for a week's time.

7. Write your group's number on the container.

Summary:

1. How are you providing the seedlings under one cover with the same amount of light?

2. How did you provide similar physical conditions for all the seedlings?

3. What is one known difference in physical conditions for the 4 groups of seedlings?

4. What will you do with the seedlings when you examine them at the end of seven days?

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET-LESSON 50

Problem: In what light do green plants (radish) grow best?

Materials:

Your container of seedlings
Two rulers
Your laboratory worksheets from lessons 49 and 50

Procedure and Observations:

1. Measure the height of each seedling one week later. Record the heights on the table below.

   NOTE: Do not measure dead seedlings.

SEEDLING GROUP	HEIGHT OF EACH SEEDLINE	AVERAGE GROUP HEIGHT
White light	1.____ 2.____ 3.____ 4.____ 5.____	_____
Blue light	1.____ 2.____ 3.____ 4.____ 5.____	_____
Red light	1.____ 2.____ 3.____ 4.____ 5.____	_____
Yellow light	1.____ 2.____ 3.____ 4.____ 5.____	_____

2. Look back to your table in the first laboratory lesson when you first measured the heights of the seedlings.

   Enter the average group heights in the table below. Do the same for today's results.

SEEDLING GROUP	AVERAGE HEIGHT BEGINNING	AVERAGE HEIGHT END	AMOUNT OF GROWTH	OBSERVATIONS
White light	_____	_____	_____	_____
Blue light	_____	_____	_____	_____
Red light	_____	_____	_____	_____
Yellow light	_____	_____	_____	_____

3. Write your results on the chalkboard in the spaces provided for your group.

4. Compare your group's averages with the class' averages.

5. Record any other changes in the seedlings' appearances in each group.

Conclusions:

1. Why did you use one cover with a clear plastic?

_____

2. Which sunlight color (other than the clear plastic) helps plants grow best?

_____

3. Why do you think other green plants will act the same way?

_____

4. If you have 3 colored light bulbs (red, yellow, blue), which one would you expose a green plant to? Explain why you selected this light bulb.

_____

5. What are some possible reasons why your group's averages were different than the class' averages for seedling's heights?

_____

_____

_____

51 HOW DOES A SIMPLE ORGANISM RESPOND TO LIGHT?

Advance Preparation:

About 10-12 days before this lesson is taught, prepare a euglena culture. Stock supplies of euglena may be purchased from several biological supply companies. There are also several media which can be made or purchased in which euglenas multiply. One easily prepared medium involves the boiling of 50 split pea halves in 1 quart of water for 15 minutes. Strain the "soup." Discard the solid residue. After the "soup" has cooled pour about ½ quart amounts into 2-600 ml beakers. Inoculate each beaker with the stock supply of euglenas. Keep both cultures illuminated by an indirect artificial light source for 10-12 days. Keep the culture free of dust by covering the beakers with plastic wrap perforated with small air holes. Before this lesson is taught place the 2 cultures in complete darkness. Using one of the 600 ml beaker cultures, prepare 2 small beakers covered with black paper as described in the "Development" portion of this lesson. Expose these 2 beakers to an indirect light source for 2 hours before bringing into the classroom. The pupils will see the results of this investigation based on viewing this set.

Background:

Euglena is a one-celled protist
Photosynthesis is one of its life functions. Euglena contains chlorophyll and can manufacture its own food supply when exposed to a moderate light source. Therefore, euglena will respond positively to light.

Outcomes:

Euglena moves toward a moderate light source.

Motivation:

Show pupils the culture of euglena. (Use the culture that was not exposed to 2 hours of light before the lesson.) Ask pupils to describe and speculate about the beaker's contents. Ask "How can we find out if a living organism is present in this material?" Use a microprojector to show the presence of euglena in the culture. Ask "What makes the culture green?" Pupils will recall the presence of chlorophyll in some living things. Briefly review why chlorophyll is important. Ask "What important physical condition does a euglena need in its environment?"

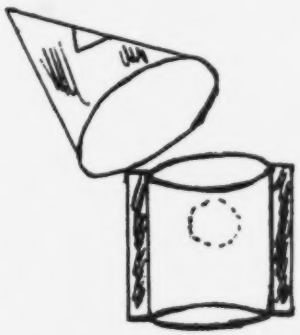
Development:

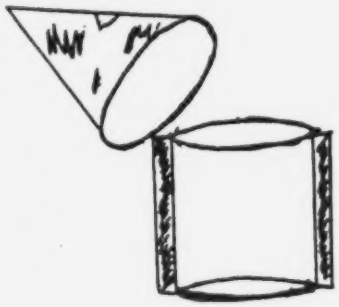
1. Ask "How can we prove that euglenas respond to light?"

Elicit that the response to light will be either movement away or towards light.

2. Pupil volunteers assist in the preparation of 2 paper covers for 2-250 ml beakers. Wrap black construction paper around each beaker. Tape down the edges. Be sure that the paper appears above the rim of the beaker. Shape a cone out of the same paper for the top of the cover. Cut a $1\frac{1}{2}$ inch diameter hole in the center of the paper surrounding one of the beakers. (Refer to the diagram in #3)

3. Pour $\frac{1}{2}$ of the euglena culture into each beaker. Cover the beakers.





4. Illuminate both beakers with an indirect artificial light source.

5. Ask "How will the euglenas behave in each beaker?" Elicit some explanations for their speculations.

6. Demonstrate the results of this classroom investigation by carefully removing the covers from the 2 beakers previously exposed to light prepared before class. Explain how these setups were prepared and treated. Pupils will recognize that the setup prepared in class is identical with the ones being viewed except for the formers' exposure to 2 hours of light. (Keep the setup prepared in class for use with other classes.)

7. Have pupils record their observations in their notebooks. Elicit that a dense euglena population is found in front of the opening. Review the need for light in order to carry on photosynthesis.

8. How will the euglena appear in the beaker that was completely covered? Why did we prepare the beaker this way?

<u>Summary</u>:

1. Why would you have to give euglenas food if they were kept

in darkness for a period of time?

2. How might euglenas be affected if a direct light source was used to illuminate the cultures?

Homework:

1. How could you show which part of the light spectrum affects euglenas the most?

2. If euglenas live in a lake, where would you expect to find the largest number of euglenas on a bright sunny day? (There are some shade trees bordering parts of the lake shore.)

Materials:

Stock culture of euglena
Split peas
Two quart boiler (2 lite flask)
2-600 ml beakers
4-250 ml beakers
Bunsen burner
Tripod stand
Wire mesh
Plastic wrap
Black construction paper
Scissors
Light source (60 watts)
Microprojector
Slide
Cover slip
Medicine dropper

52. HOW DO HIGHER ORGANISMS RESPOND TO LIGHT?

LABORATORY LESSON

Advance Preparation:

Purchase mealworms and brine shrimp (or brine shrimp eggs). If mealworms (Tenebrio) are to be cultured in school, the work must start at the beginning of the school year. The time required to hatch brine shrimp eggs is from 24 to 36 hours.

Outcomes:

- The ability of living things to respond to light helps them survive.
- Higher organisms usually respond to light with faster movements than lower organisms.

Motivation:

Elicit pupil experiences concerning the behavior of such forms as mice, cockroaches and cats when they are suddenly exposed to strong light. Point our that living things respond differently to light, some negatively, others positively. Relate examples of this behavior, (e.g., egg-laying of some species depends on amount of light, wild animals "freeze" when caught in the glare of an automobile headlight, hibernation) to amount of light.

Additional areas of exploration regarding the behavior of living things to light might also include:

- burrowing behavior of small cage animals (gerbils, white mice, hamsters)
- adaptation of nocturnal animals to hunting at night
- adaptation of animals to desert environment
- navigational ability of migrating birds

"Why is the response to light important to living things?"
"Do all living things respond to light in the same way?"
"How fast do some organisms respond to a change in the amount of light?"

Because of great pupil interest in this area, it is suggested that after the laboratory activity, this lesson be extended for a number of class periods to allow for a further study. Various films and filmstrips, reference texts, visit to a museum or zoo and to the local park or school grounds (observing ants, worms, insects) will greatly enhance this investigation.

Development:

1. Distribute worksheets and materials to each group of pupils. Adjust the shades in the room.

2. Demonstrate how to prepare the bottom part of the petri dish. Line the bottom with semi-circles of white and black construction paper. Cover the top half and sides of the dish with aluminum foil on the side lined with black paper.

3. Demonstrate how to handle mealworms with forceps.

4. Ask "Where are mealworms found in nature?"

5. Briefly describe the natural habitat of brine shrimp.

6. Show how to make a adequate cover for the flask containing brine shrimp.

Materials:

One-half of a petri dish
Aluminum foil
White and black construction paper
Mealworms
Brine shrimp in an Erlenmeyer flask
Microscope substage lamp or other suitable light source.

Homework:

1. Why do mealworms move away from the light?

2. Why must you have the light shine at a distance above the petri dish?

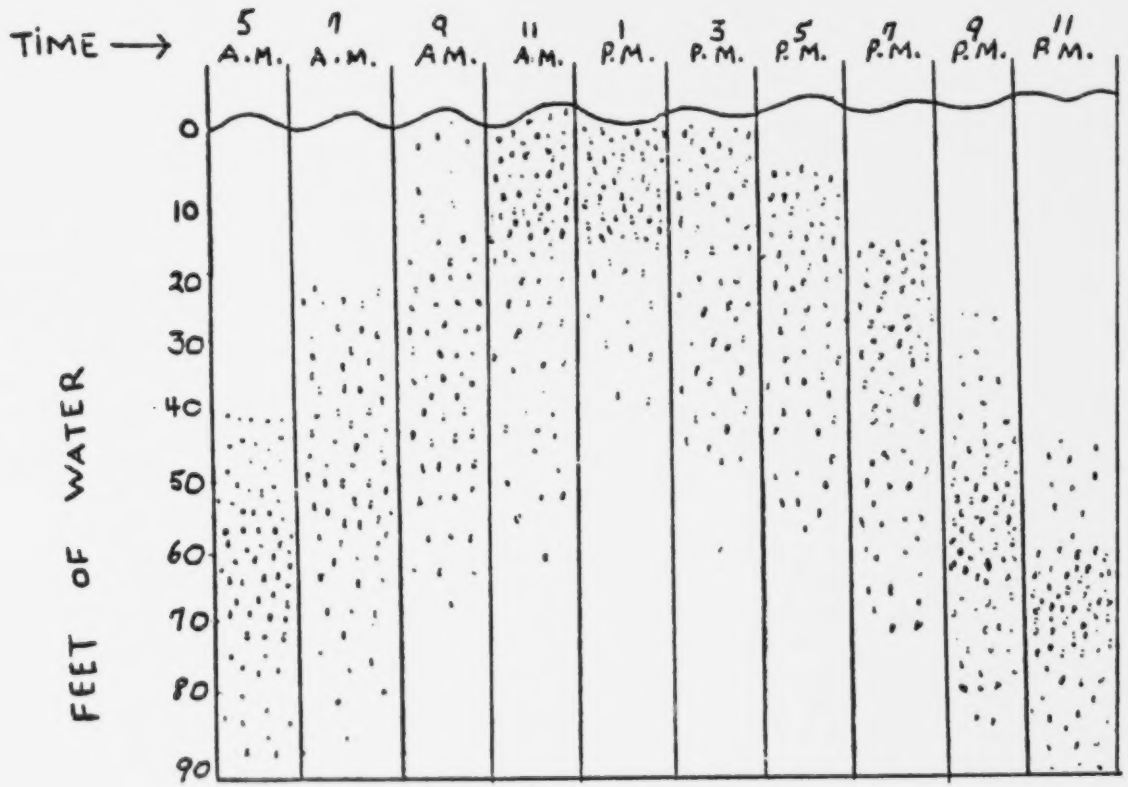
3. Why do you cover the flask containing the brine shrimp at the beginning of the period?

4. Refer to the chart below and answer these questions:

   a. In which direction do these ocean-dwelling organisms move as daytime approaches? night time approaches?

   b. What change in the environment causes these movements?

   c. Why do you think these movement occur?


TIME →
5 A.M.
7 A.M.
9 A.M.
11 A.M.
1 P.M.
3 P.M.
5 P.M.
7 P.M.
9 P.M.
11 P.M.
FEET OF WATER
0
10
20
30
40
50
60
70
80
90

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET LESSON 52

Problem:

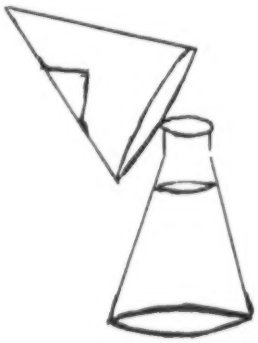
How do mealworms and brine shrimp respond to light?

Materials:

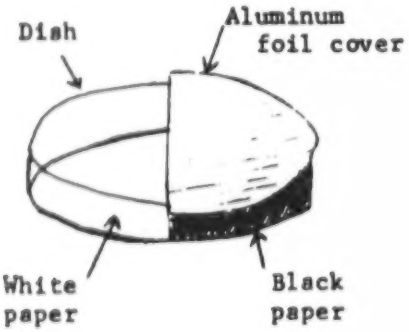
One-half of a petri dish
Aluminum foil
White and black construction paper
Scissors
Forceps
Light source
3 Mealworms
200ml Erlenmeyer flask containing brine shrimp
Tape

Procedures and Observations:

1. Cover the Erlenmeyer flask containing the brine shrimp with black construction paper. Put this aside until step 6 is reached.



2. Cut out 1/2 circles of black and white construction paper to line the bottom of the petri dish. Tape the 2 halves together to form a circle. Cover 1/2 of the dish with aluminum foil on the side with the black paper lining.



3. Use forceps to place 3 mealworms in the middle of the dish.

4. Shine the light above the dish.

5. To which side of the dish do the mealworms move?

	Dark Side	Light Side
Mealworm #1 Mealworm #2 Mealworm #3		

6. Your teacher will turn off lights in the room. Turn on the lamp. Remove the cover from the flask. Place the lamp so that it shines towards one side of the flask.

7. In which direction are the brine shrimp moving?_____

_____

8. After a few minutes have passed, where are most of the brine shrimp? _____

9. Cover the flask again for a few minutes. Place the lamp <u>above</u> the mouth of the flask.

10. In which direction are the brine shrimp moving? _____

_____

<u>Summary</u>:

1. What change in the mealworms' and brine shrimps' environment did you make?

2. How do you know that the mealworms and brine shrimp were affected by the change in their environment?

3. Do the brine shrimp and mealworms respond quickly or slowly to the change in their environment?

7. Using pictures or films, discuss the symptoms of rickets and its effect on the long bones. Tell pupils that ultraviolet rays cause a substance in the skin to form vitamin D. Vitamin D is necessary for normal bone development in the young child. Ask "How would exposure to some sunlight prevent rickets?"

8. Ask "Why might it be necessary for all newborn children to have vitamin D added to their diets as more pollutants enter the atmosphere? Have pupils understand that smoke and dust act as a screen through which ultraviolet rays cannot penetrate.

Summary:

1. Sunlight is both harmful and helpful. Explain this statement.

2. Why are infants who are placed in sunshine coming through a glass window unable to make their own vitamin D?

Homework:

1. How many pollutants in the atmosphere affect vitamin D production in infants?

2. How can you protect your skin and eyes from the harmful effects of sunlight?

Materials:

Radiometer
Sunglasses
Samples of suntan lotions (semi and full filters)

Pictures or Transparencies:
- Sunburnt people
- Children with rickets
- Sunlight spectrum (visible and invisible)

53. HOW DOES SUNLIGHT AFFECT YOU?

Outcomes:

Sunlight helps you to manufacture Vitamin D.

Exposure to sunlight causes a darkening of the skin's color.

Overexposure to sunlight can be harmful.

Motivation:

Pair off pupils. Have one pupil cup his hand over one eye. The other pupil observes the uncovered eye for eye-pupil size. After a minute has passed the hand is removed from the eye. The observer now will see the effect of light upon the size of the pupil. The observer now becomes the subject. Ask "How does light affect your eye? How do your eyes repond to sunlight when you leave a darkened room? Why doyour eyes have this ability?"

Development:

1. Ask "How does your skin protect you from sunlight?" Elicit that the coloring material in the skin increases in amount when the skin is exposed to moderate sunlight. This increase in coloring material darkens the skin color and protects the individual.

2. Illustrate the effects of overexposure to sunlight by showing pictures of people with severe sun burns. Have pupils understand that some people do not produce enough of the coloring material in the skin or that they overexpose themselves to strong sunlight.

3. Show a chart or transparency of the sun's spectrum. Point out the visible and invisible portions of the spectrum. Have pupils describe the portion of the spectrum after the blue and violet portions. Tell pupils that the ultraviolet portion of the spectrum is responsible for the darkening of the skin. Ask "Why can people get sunburnt even on a cloudy day?" Elicit that ultraviolet rays can pass through clouds.

4. Briefly discuss the harmful effects of ultraviolet rays: sunburns; possible cause of skin cancers; destruction of the sensitive parts of the eye.

5. Ask "Why do people use suntan lotions?" Examine several kinds of suntan lotions. Elicit that some or all of the ultraviolet rays are filtered out by the suntan lotion.

6. Demonstrate how sunglasses cut down on the amount of sunlight reaching the eye. Place a sunglass between the sun's rays and a radiometer. Ask "How do sunglasses help protect your eyes?"

54. HOW DOES THE SUN'S ENERGY HELP WATER ENTERING AND LEAVING THE ATMOSPHERE?

Outcomes:

- The flow of water from the ocean to the atmosphere to the land and back to the ocean is known as the water cycle.
- The energy that drives the water cycle comes from the sun.

Motivation:

Write this quote on the chalkboard:

"All the rivers run into the sea;
yet the sea is never full."

Have pupils interpret this quote. Guide the pupils to understand that although a great deal of water enters the oceans from rivers, streams and rain, the level of the sea water remains constant.

Development:

1. Demonstrate the effect of heat upon the evaporation of water. Add water to 3 quart-sized jars to the one-third mark. Cover the jars. Place each jar on its long side. Keep one jar in a shady spot, another under a 200 watt light bulb and the third in direct sunlight.

2. Have pupils speculate on how the jars' surroundings will affect the water in the jars.

3. Demonstrate the formation of condensed water on the inside of the jar. Switch off the light. Pupil assistant then rubs an ice cube over the top surface of each jar. Draw attention to the drops of water on the inside top surface of the jar.

4. Ask "Where does the water come from that forms on the inside of the jar?" Elicit that heat causes the water to evaporate and that cooling the surface of the jar causes the water vapor to condense. Summarize by having pupils define the words "evaporation" and "condensation."

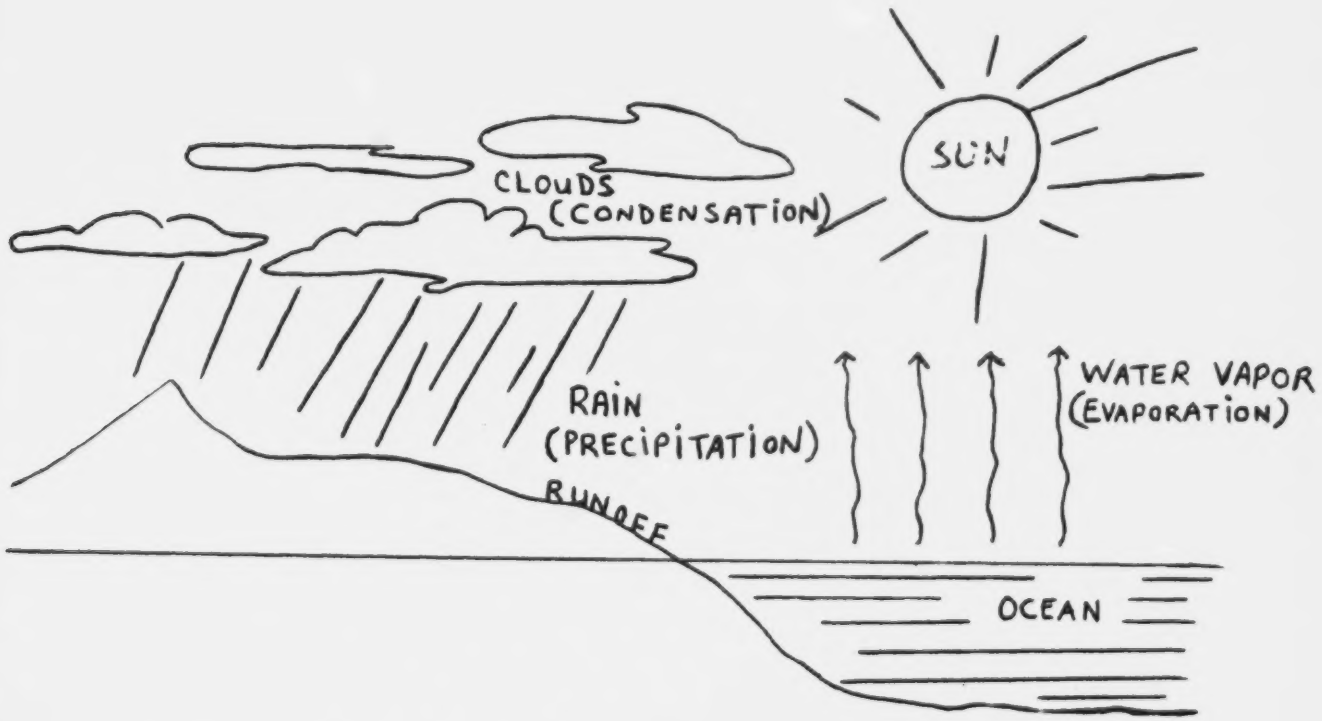
5. Place the following chart on the chalkboard. Pupils fill in the missing items. Tell the pupils to use the words, small, medium, large in the chart.

Jar	Amount of Water Evaporated	Amount of Water Condensed
Shady Place		
Sunlight		
500 - Watt Light Bulb		

6. Challenge the class to explain why different amounts of water evaporate in each year.

7. Relate the water cycle in nature to the demonstration just completed. Elicit that the sun's energy drives this cycle. Point out that about 23% of the incoming solar radiation absorbed by the earth goes into the evaporation of water. Have pupils discuss the relationship of condensation to precipitation.

8. Review the principles of evaporation and condensation as depicted in the diagram below. (Transparency of water cycle and overhead projector may be used.)



Guide the pupils to observe that:

a) the oceans yield water to the atmosphere mainly through evaporation.

b) this water is transported by the moving air in the form of water vapor (a gas). The vapor condenses and becomes clouds.

c) eventually the water falls back to earth, either as a snow or rain (precipitation)

d) water that falls on land will return to the oceans by means of rivers, streams and ground water. Thus the cycle is completed.

9. Draw attention to the opening motivation. Ask "Why is the level of the oceans always about the same?" Elicit the fact that precipitation and evaporation of water from the ocean keep the level about the same.

Summary:

1. List the places on the earth where water evaporates.

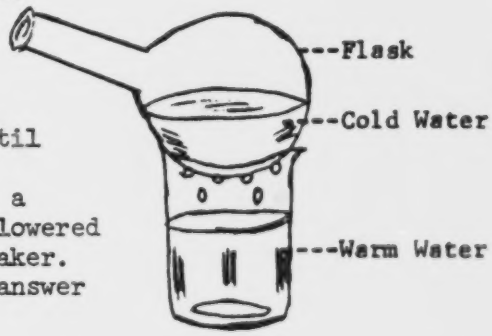
2. List the ways water returns to the earth.

3. Where does the energy come from that causes water to evaporate from the earth?

4. What is the water cycle?

Homework:

1. A pupil pours heated water into a beaker until it is two-thirds full. Cold water is added to a flask. This flask is lowered onto the rim of the beaker. Study the picture and answer the questions.



a) What are the small drops called that can be seen on the flask?

b) Where do these small drops come from?

c) This pupil believes that this setup shows what happens in the water cycle. Do you agree? Explain your answer.

Materials:

3 Quart-sized jars with covers
200 Watt light bulb in a lamp
Water
Ice cubes
Paper towels
Transparency of water cycle
Overhead projector

55. HOW DOES THE SUN HEAT THE EARTH AND ITS ATMOSPHERE

Outcomes:

. When matter absorbs radiant energy its temperature increases.

. Most of the sunlight which strikes the earth's surface is changed to heat energy.

. The atmosphere keeps the earth warm.

Motivation:

Project the cartoon onto a screen

SUMMERTIME...
HOT DAY — THINK I'LL TAKE OFF MY SHOES.
I WOULDN'T DO THAT
WOW! HOT FOOT!
HA! HA!
AND HE THINKS HE'S A SCIENTIST.
HOW DID THAT HAPPEN?

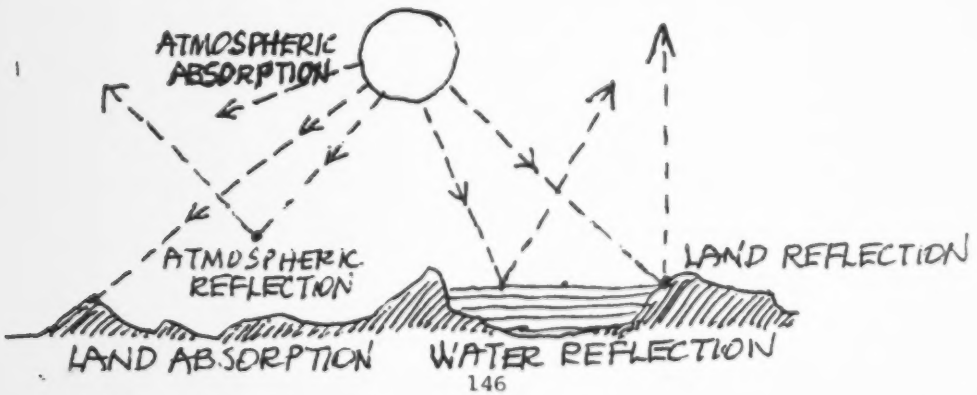
Ask, "Why is it foolish for the boy to take off his shoes? How does the girl know that the sidewalk is hot even though she keeps on her shoes?"

Development:

1. Recall the transfer of radiant energy to the earth.

2. Ask the class, "Does all of the radiant energy reaching our atmosphere reach the earth?" Demonstrate the passage of light through glass, the reflection of light by a mirror, and the absorption of light by a piece of black construction paper. Have pupils discuss the temperature change on these things when sunlight strikes them.

3. Prepare a transparency or rexograph of the diagram below. Have pupils examine the diagram. Challenge pupils to describe what happens to sunlight when it reaches the earth and its atmosphere.



Ask, "What part of the earth's atmosphere will reflect sunlight back into space?" How does this sunlight affect the temperature of the atmosphere and earth?" Guide the pupils to understand that only when sunlight is absorbed are the atmosphere and earth heated. "What substances in the atmosphere absorb light energy? Where else is light energy absorbed?"

4. Discuss the heat energy radiated by materials which absorb light energy. Relate this concept to the cartoon where the girl senses that the sidewalk must be very hot if the air above it is very warm. Elicit that the light energy is absorbed by materials composing the sidewalk and radiated to the air above it in the form of heat energy.

5. Ask, "How does the atmosphere get its heat?" Refer to the diagram and point out that the various gases, including water vapor, and dust absorb some sunlight. Heat is then radiated to the atmosphere (and also to the earth). Sunlight which reaches the earth is absorbed and some is radiated to the atmosphere.

6. Challenge the class to explain how the atmosphere helps keep the heat energy from escaping all at once into space. Call attention to the ability of water vapor and carbon dioxide in the atmosphere to absorb heat energy (infrared part of the spectrum). Illustrate this "trapping" of heat to the function of a bed blanket in keeping a person warm. Relate this description to the "invisible blanket" effect of the atmosphere in maintaining heat for the earth.

7. A suitable demonstration to illustrate this effect is described below. If time permits, start at the beginning of the class period. Demonstrate the effect of a cloudy sky versus a clear, dry sky on the loss of heat from the earth. Prepare, in advance, 3 culture dishes filled with topsoil. Place a thermometer just below the soil surface in each culture dish. At the beginning of the period place a heat lamp above the culture dishes. Note the room air temperature. Turn on the lamp. When the temperature rises 20°C above room temperature in each setup turn off the lamp. Prepare, in advance, two dome shaped plastic covers. Cover the entire surface of one of the transparent covers with seven or eight layers of plastic wrap. When the lamp is turned off cover two of the culture dishes with the covers prepared in advance. Record the temperature in each setup every four minutes for a 16 minute period of time. Keep a record of the temperature change, if any, in a chart.

	Time in Minutes				
Setup A (uncovered)	0	4	8	12	16
Setup B (covered)					
Setup C (covered plus 7 layers of plastic wrap)					

8. Ask the class "Which setup showed the least ground temperature change?"

9. Lead pupils to see that setup C best represents the effect of a cloudy atmosphere on the loss of heat. Challenge the class to relate the changes in the ground temperatures in the demonstrations to the "invisible blanket" effect of the atmosphere in maintaining heat for the earth.

10. Have the pupils compare setup C to the earth.

Summary:

1. Why must astronauts be protected against heat if outer space is cold?

2. How might an increase in the carbon dioxide content of the atmosphere affect temperatures on the earth?

3. Why is the air usually warmer on a cloudy night than on a clear night?

Homework:

1. Why does a glass window feel cool even though the sun shines on it?

2. Why does a mirror feel cool even though the sun shines on it?

3. Why does your skin feel warm when the sun shines on it?

4. What must happen to sunlight in order for the atmosphere to be warmed by it?

5. How do water vapor and carbon dioxide prevent the loss of heat all at once to space?

Materials:

Light bulb
Heat lamp
Glass pane
Mirror
Black construction paper
Ring stand and clamp
3 Culture dishes
2 Dome shaped transparent covers
Soil
4 Thermometers
Plastic wrap
Projector

56. HOW IS HEAT CIRCULATED AROUND THE EARTH?

Outcomes:

. Convection currents produce the circulation patterns of the air and water on the earth.

. Heat is circulated around the earth by ocean currents and winds.

Motivation:

Add a few grains of black pepper to cold water in a 600 ml beaker. When the pepper grains sink to the bottom, place a Bunsen burner, with a low flame, under one end of the beaker. Ask, "Do the pepper grains rise faster than they sink? Why? How does this demonstration explain how heat is circulated in a small body of water?"

Development:

1. Fill a rectangular aquarium tank with water to a depth of 6 inches. Determine that the temperature of the water is uniform throughout. Place 2 thermometers at one end of the aquarium so that the bulb of one thermometer is just off the bottom and the bulb of second one is about 2 inches below the surface of the water. With a pair of tongs gently lower an ice cube colored with food coloring into the opposite end of the tank. Have pupil assistants read and record in a chart on the board the temperature readings on both thermometers at one-minute intervals until the ice has completely melted. Ask, "What has occurred in the tank of water?"

2. Relate this demonstration to the movement of ocean currents. Elicit that warm water from the equator flows north and south. At the poles the water is chilled and sinks to the bottom. The water then flows very slowly toward the equator at great depths.

3. Show a chart of some of the major currents in the Atlantic Ocean. Challenge the class to predict how the Gulf Stream affects the temperature of the surrounding waters it passes by. Elicit that a current is a part of the ocean that freely flows in a definite direction.

4. Demonstrate convective circulation in air with the Convection Box. Point out that the air near the candle is similar to air near the equator. Ask, "How do air movements circulate heat around the earth?" Elicit that warm air is pushed up near the equator by cooler air that flows from the poles.

5. Draw on the board the air movements in a cumulus cloud. Have pupils discuss the circulation of heat energy in this small convective system.

6. Illustrate the direction of air movements in sea and land breezes. Ask, "How do these local winds help to circulate heat?"

Summary:

1. What effect does the sun have upon air and water?

2. Compare heat circulation in a small body of water to the one found in an ocean.

3. How do ocean currents circulate heat on the earth?

Homework:

1. A boy opens a window from the top and bottom on a calm day. He holds a long strip of tissue paper near the window sill and another one directly above the first one near the opened top window.

   a) In which direction does each strip blow?

   b) How is the heat circulated in this small area of the room?

2. Why were seamen, before the use of power engines, dependent upon ocean currents?

3. Why do you get a "bumpy" ride in an airplane when it passes through cumulus clouds?

Materials:

Black pepper	600 ml Beaker
Pair of tongs	Bunsen burner
Ocean current chart	Tripod stand
Convection box	Wire mesh
Smoke paper	Rectangular aquarium tank
2 tissue paper strips	2 Thermometers
Ice cube colored with food dye	Matches

57 HOW HAS THE SUN'S ENERGY BEEN STORED ON EARTH?

Outcomes:

. The sun's energy was trapped by green plants.

. Fossil fuels are the remains of living organisms.

. Fossils fuels cannot be replaced.

Motivation:

Project the cartoon on a screen. Have the pupils comment on the origin of the leaf print on the piece of coal. Ask, "Where does the energy in the coal come from?" Briefly recall the process of photosynthesis.

Development:

1. Investigate energy sealed in plants by heating leaves and twigs in a flask. The gas emitted is ignited. Ask, "How did these parts of plants get this energy?" Elicit that through the photosynthetic process the sun's energy was stored.

2. Burn a piece of peat. Tell pupils that this is the first stage in the formation of coal. Challenge pupils to suggest what is the composition of peat.

3. Using films, film strips or slides, show pictures of the Pennsylvanian Period. Have pupils describe the environment in which these plants lived. Lead the pupils to see that these ferns and mosses died and were buried in swamp water. They decayed and only carbon remained.

4. Display peat, lignite, bituminous and anthracite coal. Show leaf imprints in coals samples, if available. Define a fossil fuel.

5. Demonstrate the burning of a small amount of oil in a crucible and gas from a Bunsen burner. Challenge the pupils to identify the origin of these fossil fuels. Elicit that oil and natural gas are derived from the fossil remains of plants and animals.

6. Ask, "Why is it necessary to look for new sources of coal, oil, and natural gas?" Lead pupils to understand that fossil fuels cannot be replaced. Explain that it took millions of years of heat and pressure to produce the fossil fuels. "How does increased population and industrial technology affect the available supply of fuels?"

Summary:

1. Why are leaf imprints sometimes found in coal?

2. A pupil reads the following: When coal and oilare burned to heat our homes, it is really the sun, which shone millions of years ago, that is heating our homes. Explain.

Homework:

1. Why are coal, oil and natural gas called fossil fuels?

2. How does the sun's energy become locked into fuels?

3. Why must fossil fuels not be wasted?

Material:

Erlenmeyer flask
One-hole stopper fitted with a right angle bend glass tube tappered at the end.
Ring stand
Ring clamp
Bunsen burner
Samples of Peat, Lignite
Bituminous and Anthracite coal
Petroleum
Crucible
Pair of tongs
Wire mesh
Test tube clamp
Coal with fern imprints
Pictures of Pennsylvanian Period

58. HOW MAY MAN USE SUNLIGHT AS A DIRECT SOURCE OF ENERGY?

Outcomes:

. Solar energy can be trapped and used as a source of heat energy.

. Solar energy can be converted to electrical energy.

Motivation:

Write the words "Solar Farm" on the board. Ask pupils to describe the function of these "farms." Elicit that these future "farms" may be developed to collect sufficient sunlight which could be used to produce electrical energy.

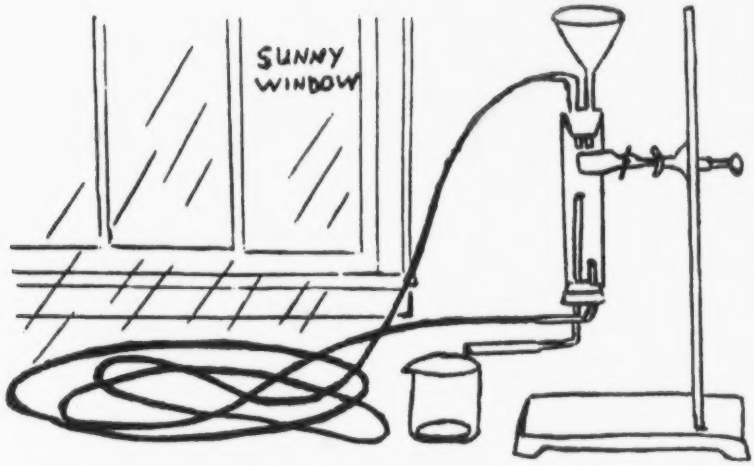
Development:

1. Have pupils point out places on a map of the United States where solar farms might be built. Challenge pupils to give reasons for their selected sites. Point out that large desert areas would be most suitable because of the amount and intensity of sunlight in these areas.

2. Demonstrate the effect of sunlight on a light meter used by a photographer. Elicit that sunlight striking the meter causes an electric current to be produced.

3. Ask "What will have to be developed before "solar farms" are put into operation?" Point out that solar cells, found on spacecraft, convert sunlight to electrical energy with greater efficiency than is done in light meters. These solar cells will have to be spread over large areas of land.

4. At the beginning of the period set up a demonstration solar heater. Connect a long piece of black rubber tubing to a cylinder of water as shown in the diagram. Challenge pupils to explain how warm water gets from the tubing to the cylinder. Elicit that the water in the black tubing absorbs solar energy and the water circulates to the cylinder in the shade by convection.



Call attention to the present operation of solar water heaters in Australia, Israel and Japan. Display charts and pictures of a solar heater. Elicit that a solar heater consists of a black metal surface under glass on the roof of a house. Warmed water is stored in an insulated tank.

5. Discuss the problems affecting the practical use of solar energy. Elicit that regular hourly, daily and seasonal changes and irregular cloud-cover variations affect the solar energy arriving at a particular area.

6. Stimulate discussion concerning what the future may bring in using satellite solar-power stations to convert solar energy to a form of radio-like energy, transmitted to earth stations and changed to electrical energy.

Summary:

1. Why is very little sunlight used as a source of energy?

2. Why is a black surface used in solar heaters?

3. Why would it be better to trap sunlight in outer space than on the earth?

Homework:

1. Why is man interested in converting sunlight to heat and electrical energy?

2. What factors in the environment will affect the amount and intensity of sunlight striking an area of land?

3. Would you like to have your home heated by solar energy? Explain your answer.

Materials:

Map of the United States
Light meter
Funnel
3-Right angle bend glass tubes
1 Glass cylinder
2-Two-holed rubber stoppers
Four feet of rubber tubing
Beaker
Ring stand and clamp

B. MAN USES OTHER FORMS OF ENERGY

59. HOW CAN WE HARNESS THE ENERGY OF WINDS?

Outcomes:

- The force of winds increase as their speed increases.
- Wind moves sail boats by pushing against their sails.
- The mechanical energy of winds can be changed to electrical energy.
- Wind is not a dependable source of energy.

Motivation:

Teacher sets up two electric fans in such a way that when one is connected to an electrical outlet and turned on it will cause the blades on the second fan (not connected to an electrical outlet) to move. Tie a piece of string to the shaft of the fan not connected to an electrical source. Attach a small weight to the end of the string. Tell the class to describe what happens when the fan is turned on. Elicit that the fan receives its energy from the air moving over its blades and the weight is lifted.

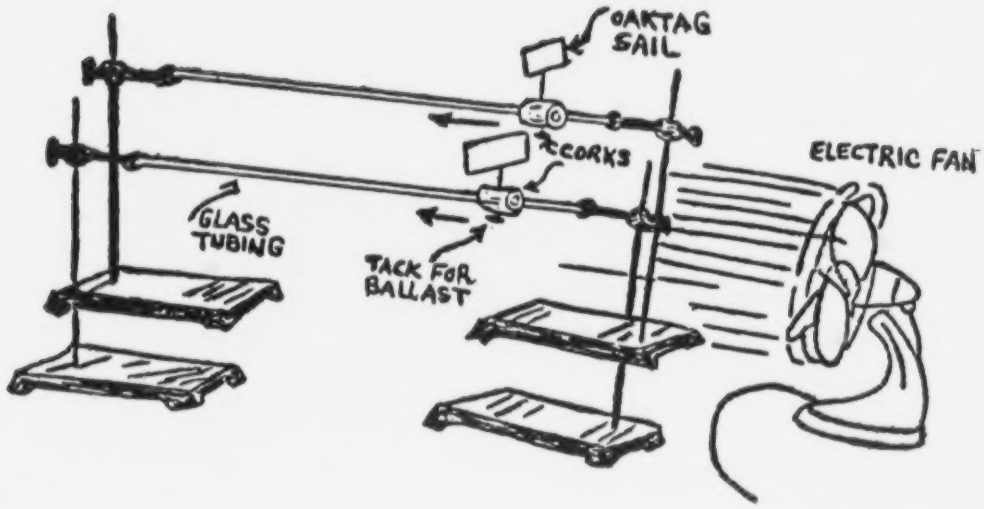
Development:

1. Display pictures or models of windmills. Have the pupils describe several present day uses of windmills.

2. Point out the differences in structure of windmills used years ago and present ones in use. Indicate that a modern windmill has huge propellers instead of vaned sails. Ask "How are these modern windmills used in some parts of the world today? Elicit that these windmills are used to generate electricity.

3. Have pupils report on sailboats and sailing vessels.

4. Demonstrate some of the ways sails can be made more effective. Set up the demonstration according to the diagram below. One "sail" is one inch square and the other "sail" is two inch square. Set both corks at one end of the tubing cloest to the fan. Tell pupils to note which cork is blown to the other end first. Pupils recognize that the cork with the larger sail moved faster.



5. Place an anemometer in the path of the wind produced by a fan. Move the fan close to the anemometer and then farther away from it. Have pupils explain the reason for the difference in rotation speed of the anemometer. Demonstrate the effect of wind speed on the one inch square "sail" used in part 4. Place the anemometer at the far end and the cork with the "sail" at the end cloest to the fan. Turn on the fan. Have pupils note the time needed for the cork to move from one end of the glass tube to the other end. Now move the fan further away from the cork and repeat the procedure. Have pupils conclude that as the wind speed increases, the cork moves faster.

6. Ask "Why is wind not a dependable source of energy?""How could this non-polluting source of energy be stored?" Elicit that the electricity produced by modern windmills will have to be stored, e.g., in batteries.

7. Review the role of the sun in producing winds. Illustrate movement of air with a convection box or a pin wheel held over an alcohol lamp.

Summary:

1. How might winds be used to produce useful energy?

2. A sailboat really receives its energy to move from the sun. Explain.

Homework:

1. How may winds be made a more dependable source of energy?

2. How does wind speed affect the energy developed by a windmill?

3. During a storm, why are a ship's sails taken in?

Materials:

2 Fans
String
Small weight
4 Ring stands
4 Test tube clamps
2 Glass rods
2 -1-hole cork stoppers
Oaktag
2 Thumbtacks
2 Straight pins
Anemometer
Alcohol lamp
Pinwheel
Convection box
Smoke paper
Pictures of windmills

60. HOW IS MOVING WATER USED AS A SOURCE OF ENERGY?

Outcomes:

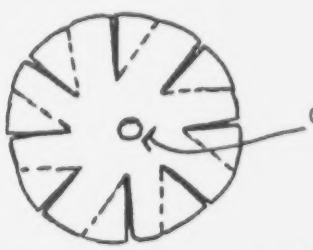
- Falling or moving water is a source of energy.
- The force of moving water can turn electric generators to produce electricity.

Motivation:

Have pupils report on the history of the use of water wheels. Point out that water wheels were used to raise buckets of coal and iron ore out of mines and turn machines in early factories.

Development:

1. Distribute a piece of cardboard, scissors, thread and a small weight to several groups of pupils. Instruct pupils to construct a cardboard water wheel. Refer to diagram below. Pupils attach the small weight to the string and tie the string to one end of a pencil. The pencil is used as a shaft. Have pupils note how fast the wheel turns when holding it under a water faucet. The water is run slowly and then quickly. Pupils should also note that when the blades turn, the pencil (shaft) turns the thread winds up and the weight is lifted.



Cut cardboard on solid lines.
Fold on dotted lines.

2. Summarize pupil activity by having pupils conclude that running water can do work.

3. Show how a model generator works. Ask "How can the force of moving water be used to operate an electric generator."

4. With a transparency of a hydro-electric dam, explain how water flowing through huge waterwheels will make electric generators produce electricity.

5. Challenge pupils to describe how tides may be a source of useful energy. Describe how tidal power is obtained from the filling and emptying of a bay that can be closed by a dam. Ask "When will the enclosed area be filled with and emptied of water?" Elicit that the filling and emptying of the area will occur only at high tide and low tide.

6. If time permits, demonstrate the operation of a model tidal system. Divide an aquarium tank into two compartments with a thick plastic divider. Cut a V-shaped notch in the center of the top edge of the plastic divider. Add water to the tank until the water is half way up the V-shaped notch. On both sides of the divider there are equal amount of water. Suspend a plastic paddle wheel from a bar supported by the sides of the tank and at the surface of the water. The paddle wheel is placed directly in front of the V-notch and midway in the compartment. Slowly add water from a 1 liter graduate cylinder to the compartment without the paddle wheel. Ask "How does the current affect the paddle wheel?" Relate this movement of water to the current flow at high tide.

7. Use a siphon tube to remove the same amount of water from the compartment to which it was added. Call attention to the reverse flow of current. Ask "What happens to the paddle wheel?" Recall the tidal power which is produced when the tide reverses itself. Ask "How can this tidal power be used?"

8. Have pupils report on possible sites where tidal power may be a useful source of non-polluting energy. A tidal electrical plant now in operation is found off the coast of France (Rance estuary).

Summary:

1. How is electricity produced at Niagara Falls?

2. How may the tides be used to produce electrical energy?

Homework:

1. Draw or describe how the water wheel you made in class could be used to operate a small, circular saw.

2. Where will tidal electrical plants be developed?

Materials:

Cardboard squares

Scissors

Thread

Small weights

Model generator

Transparency of hydroelectric dam overhead projector

Aquarium tank - 10 gallon size

Plastic divider

Plastic paddle wheel

Graduate cylinder - 1 liter wooden rod

Siphon

61. HOW CAN MAN USE HEAT INSIDE THE EARTH TO GET ENERGY?

Outcomes:

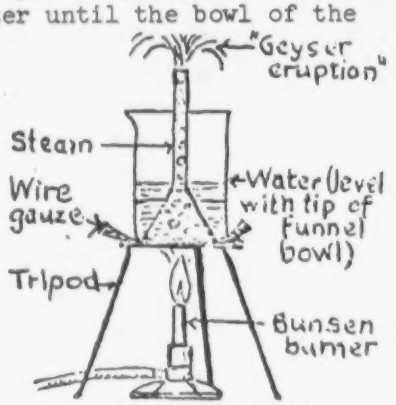
- Geothermal power is obtained by removing the heat that is stored in the earth.
- Water serves as the medium by which the heat within the earth can be transferred to the surface.
- Geothermal energy may be used as a direct source of heat or converted to electrical energy.

Motivation:

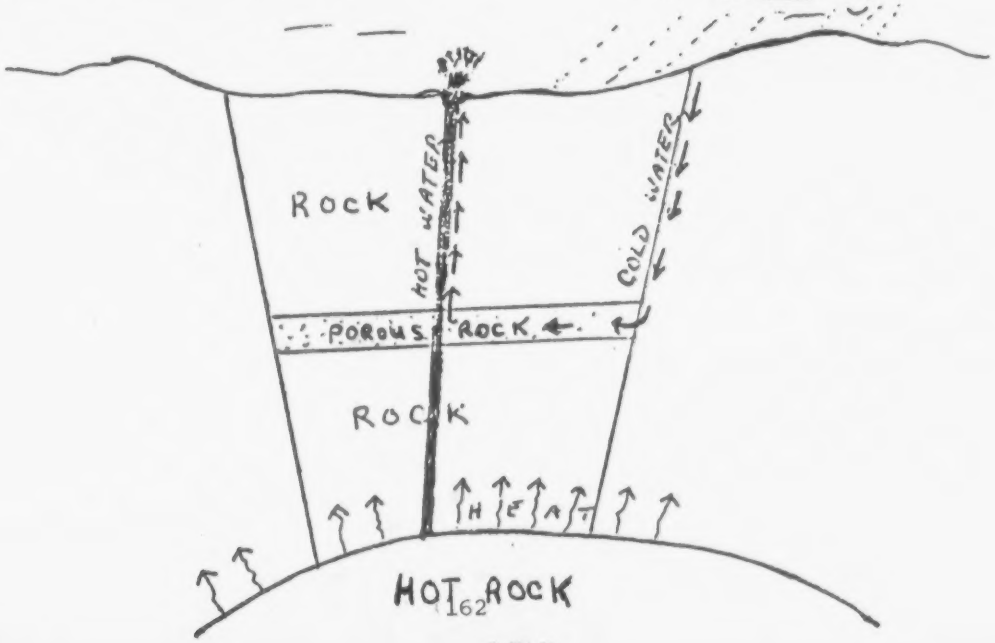
Show a filmloop or filmstrip on volcanoes. Ask "What is the source of energy that is released during a volcanic eruption?" "Where does it come from?"

Development:

1. To demonstrate the principle of a geyser eruption, place a short-stem glass funnel inverted in a beaker. Add water until the bowl of the funnel is covered. Place the beaker over heat. Call attention to the bubbles of steam which push the hot water up the stem of the funnel as they expand.



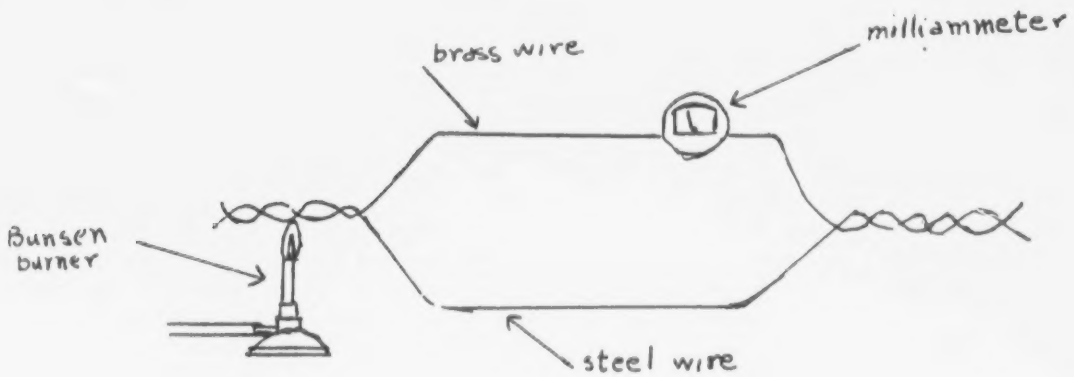
2. Ask, "Where does the water in a natural geyser get heated?" Show a transparency on the overhead projector of the diagram below. If available, show slides of the geysers in Yellowstone National Park.



"Where did the hot steam and water that shoots out from a geyser originally come from?" (Surface rain water.) "Why does this water get hot?" Define "GEOTHERMAL ENERGY" as heat energy that comes from deep in the earth.

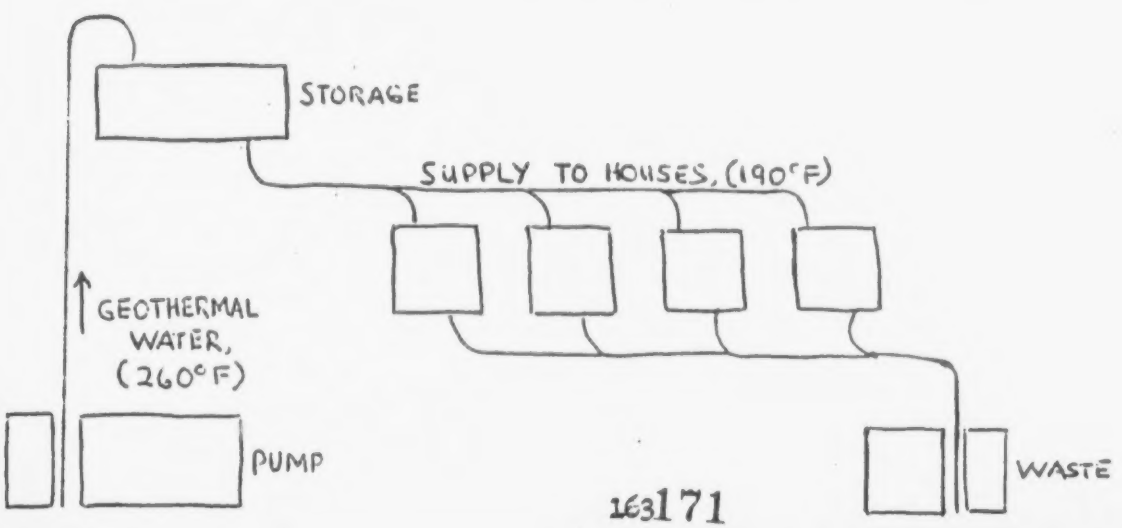
3. Ask "How is geothermal energy used today?" Elicit that the major use is for the production of electricity. Geothermal steam is expanded into a turbine that drives a conventional generator to produce electricity.

4. "Can we use the heat energy directly to make electricity?" Demonstrate the operation of a thermocouple. Show the production of a weak electric current on a meter. Point out that two different metals are used and that there is a different temperature at each end.



5. Point out the features of geothermal energy. Electricity produced from this energy source is free of atmospheric pollutants, but the water contains chemicals which can pollute streams and ground water.

6. Ask "How can geothermal water be used to heat homes?" Develop the need for a storage tank and a place for removal of wastes. Show a simplified diagram of this heating system.



Summary:

1. Why should geothermal energy be used as a source of energy?

2. Where are geothermal sources of energy found?

3. How could the earth's storehouse of heat be used to make electricity?

Homework:

1. It is believed that in the country of Ethopia there is enough geothermal energy to supply all of Africa with its need for electricity. How will the lives of the people of Africa change if this energy can be used?

2. There are no sources of geothermal energy near New York City. How will you benefit from the use of this source of energy in other parts of the world?

Materials:

Short-stem glass funnel
Beaker
Wire mesh
Tripod stand
Bunsen burner
Transparency of a geyser
Overhead projector
Filmstrip projector
Slides of geysers
Filmloop projector
Filmloop on volcanoes
World map
Thermocouple setup

62. HOW CAN WE USE ATOMIC ENERGY?

Outcomes:

- Matter is composed of tiny invisible particles called atoms.
- Fission involves the splitting of atoms.
- Fusion involves the combining of atoms.
- The heat produced from fission can be captured and changed to electricity or directly to mechanical energy.

Motivation:

How far can a car go on a tankful of gasoline? How many gallons do your parents buy each year? How much fuel does a modern jet plane use on one trip? How many gallons of fuel oil is used to heat a home? an apartment hourse? an entire city? How much fuel does an electric company have to use to generate electricity for a city the size of New York City? Encourage pupils to speculate about the large amounts of fuels that have to be used in order to create energy. Point out that a handful of radioactive elements can give you as much energy as those above. What should you know about this fuel before you would use it?

Development:

1. Ask the class "How is the energy released from this fuel?" Point out that the energy is locked up in the atoms of this fuel.
2. Have the class define what an atom is. Briefly describe the two main regions of an atom: elctrons and the nucleus (Bohr model).
3. Tell the class that energy is released from certain atoms when the nucleus of the atom is split. Refer to the atomic bomb.
4. Tell the class that if the size of one atom was increased to the size of the classroom, the nucleus would be about the size of a marble in the center of the room. Clear the center of the room and place the "nucleus" marble in the center. Place a few smaller marbles around the room to represent the electrons. Ask pupils "What is a atom composed of?" Elicit the nucleus, electrons and empty space.
5. Demonstrate the fission process by having pupil assistants roll other marbles at the "nucleus" marble in the center of the room. Point out that parts of other atoms are used by scientists to hit the nucleus and split it. Now blindfold several pupils and ask them to hit the "nucleus" marble. Explain that scientists cannot see the

nucleus that they are trying to hit and split. Ask "Why are scientists unable to see the atom's nucleus?"

6. Tell class that a tremendous amount of heat energy is produced when the nuclei of many atoms are split. Ask "How can this heat energy be used?" Elicit that electricity can be produced by transferring the heat to change water to steam. The steam then turns a turbine which then turns a generator to produce electricity.

7. Have pupils report on the voyages of nuclear powered vessels. Point out the small quantity of fuel required to power these vessels for long journeys. Tell pupils that one pound of uranium, when it undergoes controlled fission, gives an amount of heat energy equal to the energy that comes from the burning of more than 2 million pounds of coal.

8. Describe how man is trying to get energy from atoms such as hydrogen by a process called fusion. Compare the fusion process to the fission process. Ask "Where is there an abundant source of hydrogen?" Elicit that the oceans hold this vast resource of hydrogen which is a part of water. State that a hydrogen bomb exists, but man is still learning how to control this process. Refer to the energy produced by the sun as a result of the fusion process.

9. Display pictures of nuclear power plant and a typical fossil fuel power plant. Tell pupils that both plants produce electricity. Ask "What appears to be missing in the nuclear power plant that is found in the fossil fuel power plant?" Elicit that the giant smokestacks are missing at the nuclear power plant.

10. Discuss the advantages and disadvantages of atomic energy: relatively clean and abundant - dangerous waste products, possible explosions, expensive at the outset, thermal pollution of streams.

Summary:

1. Explain this statement: All energy can be traced back to nuclear energy.

2. Why are some communities fighting against the building of nuclear power plants in their communities?

Homework

1. Describe how scientists picture an atom.

2. How is energy released from an atom?

3. How many ways can you think of to use atomic energy?

Materials:

Pictures of nuclear powered vessels
Picture of a nuclear power plant
Picture of a fossil fuel power plant

63. WHAT FACTORS LIMIT THE SUPPLY OF ENERGY ON THE EARTH?

Outcomes:

- Fossil and nuclear fuels supplies are limited.
- As world populations increase, the demand for fuels for heat and power increases, resulting in a more rapid rate of depletion.
- When a fuel is burned, only a small amount of its energy is changed to useful energy.
- The harmful effect on the environment (pollution) will limit the increased use of fuels.

Motivation:

Briefly trace the use of various fuels (wood, coal, oil)and explain the advantages and disadvantages of each.
Compare the burning effeciency of fuels by igniting and burning small quantities of wood, coal and oil. If a gas outlet is available, use a Bunsen burner to show ease of igniting a gas.
Compare ease of igniting fuel (kindling temperature), color of flame and how long the fuel burns.

Development:

1. Ask the pupils "Why have there been changes in the kinds and amounts of fuels used by man?" Elicit that an increased use of fuels is the result of a greater demand for electrical energy. Also, the abundance of oil and its ease in handling makes oil the leading fuel used today. Point out that the automobile requires gasoline, a substance produced from oil. Ask "Why is man searching for new supplies of fossil fuels?" Relate increase demands with population growth, new products from petroleum, more automobiles, more highways and more demands for electricity for new electrical appliances.

2. Recall how fossil fuels were formed on earth. Point out that estimated supplies of coal, natural gas and oil will be exhausted in the not too distant future. Have pupils recognize the long period of time and special conditions that existed and must exist for fossil fuel formation.

3. Point out the increasing use of nuclear energy to supply our energy needs. Recall the problems associated with the use of nuclear energy. Elicit that fissionable fuels are also in limited quantities in the earth.

4. Describe the energy conversions involved in making cars, ships, and planes operate. Point out the loss of energy (as heat) to the surroundings when a fuel is changed to a useful form (work or power).

5. Ask pupils "How is the excess low energy steam from steam turbines used in N.Y.C.? Elicit that this "waste product" steam is used to heat buildings in N.Y.C.

6. Have the class describe the environmental effects of increased use of fuels. Use the automobile as an example of a major polluter: automobile exhaust contains harmful gases and much of the energy in gasoline leaves an automobile in the form of non-usable heat. Ask "Why may there be further limits on our supply of energy as we become more concerned about the environment?"

Summary:

1. Why are scientists trying to find out safer ways to use nuclear fusion as a source of energy?

2. How does a fossil fuel power plant pollute the environment?

3. Why may we have to limit our use of fuels?

Homework:

1. Why is man exploring the ocean floor for oil deposits?

2. What are some of the problems connected with the use of nuclear energy?

3. How can you cut down on your use of electricity?

Materials:

Small samples of coal, wood and Bunsen burner
oil
3 porcelain crucibles
3 tripod stands
3 pieces of wire mesh

C. FORCES THAT CHANGE THE ENVIRONMENT

64. WHAT ENERGY FORCES ARE BUILDING UP THE FACE OF THE EARTH?

Outcomes:

- Some of the changes on the surface of the earth are very rapid: volcanoes and mountain building.
- Materials that are carried by wind and water from one place are built up into new land forms in other places.
- Energy for mountain-making processes is believed to be provided by heat within the earth which gives rise to convection currents.

Motivation:

Show a film or film strip illustrating volcanic eruptions, faulting and earthquakes. Guide the pupils to conclude that some changes in the earth's surface are very rapid.

Development:

1. Changes that occur over a long period of time may be demonstrated in the way in which sediments in water form layers. Stir up a little gravel with some sand and soil, add water and pour the mixture into a battery jar. Have pupils observe that the coarser particles settle to the bottom first, followed by the finer particles. As time goes on the particles become pressed and cemented together and finally change into layers of rock. Tell pupils that about four-fifths of the land surface of the earth is covered with layers of rock that were laid down in water. Point out that the energy forces building up these layers are moving water and gravity.

2. Demonstrate how accumulated sediments may cause faulting. Place 2 books on each arm of a platform balance. Keep the books on both arms close together. On one set of books place a pan of sand. On the other set of books place a pan of water. Be sure that both sides balance one another. Note: books represent layers of rock, sand represents a mountain, water represents an ocean. Ask "How do materials from the mountain get to the ocean?" Have a pupil remove some sand and dump it into the water. Ask "How does the removal of mountain material to the ocean affect the earth's crust?" Elicit that this disturbance in the earth's crust may result in an earthquake.

3. Describe how the action of surf and waves will remove sand from a beach, transport it and deposit it at another place to build up sand bars.

The sandbars tend to create quiet bays and harbors.

4. Demonstrate how mountains are formed by compression. Prepare in advance several strips of colored paper about 2 inches wide by 2 feet long. Stack these sheets on each other. Instruct a pupil to place one hand near each end of the stack and push the papers toward the middle. Elevations and depressions form which illustrate those that occur when the earth's crust is compressed into folded mountains.

5. Point out that there is heat within the earth. Conclude that this heat sets up convection currents within the earth. Recall the convection currents set up in water that is being heated. Point out that these convection currents result in a compression of the earth's crust and folded mountains form.

6. Demonstrate how the force of the wind can move sand particles to build up sand dunes. Place a pile of dry sand at the bottom of a large carton with one side cut away. Fix a five inch long dowel in the center of the bottom of the carton. Place an electric fan in front of the opening of the carton. Turn on the fan. Ask "Where does the energy come from that moves the sand? Where is this land formation being formed?"

7. Prepare in advance a long narrow box containing soil. Early in the period place a few ice cubes on top of the soil at one end of the box. Raise this end of the box so that the ice cubes will slowly move down the incline. Have pupils examine the bottom of the ice cubes. Challenge pupils to relate this demonstration to the action of glaciers in transferring soil and rock which are later deposited in other places. Show pictures or slides of terminal moraines. Point out areas on maps of Long Island where land deposits were made by glaciers.

Summary:

1. Where does the energy come from which causes the building up of the earth's crust?

2. How might hills or mountains form as a result of an earthquake?

Homework:

1. Describe one idea that tries to explain the mountain-building process on earth.

2. How do wind and water build up land areas on the earth?

3. Examine pictures of the ocean floor. Explain what is taking place in several regions of the earth's crust that is underneath the water.

Materials:

Battery jar
4 Equal size books
2 Aluminum pie pans
Platform balance
Beaker of sand
Beaker of water
Beaker of gravel
Beaker of soil
Film and pictures of glaciers, terminal moraines and volcanoes
Spatula
Strips of colored paper
Ice cubes
Long narrow box
Soil
Tongs

65. WHAT ENERGY FORCES ARE WEARING AWAY THE FACE OF THE EARTH?

Outcomes:

- Wind, waves, flowing streams, and glaciers are forces which wear away the face of the earth.
- Weathering of rock is the breaking down of rock when it is exposed to the atmosphere and hydrosphere.
- Water removes soil from the surface of the earth; this removal is known as erosion.
- Weathering of rock and erosion of soil requires an expenditure of energy.

Motivation:

Prepare one day in advance a glass jar completely filled with water. Leave no air space in the jar. Seal the jar tightly with the cover. Wrap the jar in a towel. Place the jar in the freezer compartment of a refrigerator. In class remove the towel and have the class examine the broken jar. Ask pupils to explain what happened. Carefully weigh a piece of dry sandstone. Place it in a beaker of water. Have the class speculate what its weight will be the next day. Also discuss what might happen if the water froze. (Examine this rock and weigh it the next day).

Development:

1. Ask "How does the freezing-melting cycle of water trapped in rocks change the appearance of mountains?" Elicit that large pieces of rock are pried away from mountains due to this alternating freezing and melting of water in the spaces and pores of rocks.

2. Apply a drop of dilute hydrochloric acid to the surface of limestone (marble chips). Tell pupils that in nature a weak acid (carbonic acid) reacts with a substance (calcium carbonate) in the rock. Elicit that pits and grooves, as well as caves, form as a result of the action of this acid. Show pictures of Howe and Carlsbad Caverns.

3. Define weathering as the process by which rocks are broken down by the energy forces of the air, wind, and water. Ask the pupils, "From where does the energy come?" Point out that the atmosphere and hydrosphere receive their energy from solar radiation.

4. Display pictures, models or slides of land affected by soil erosion. Ask pupils to state the cause of soil erosion. Elicit that soil erosion is the removal of soil by the flow of water, ice or sand.

Point out that soil erosion often begins with the falling of large raindrops on soil. Demonstrate the effect of "raindrops" on "soil." Fill the bottom of a petri dish to a depth of about one-half inch with powdered calcium carbonate. With a glass rod smooth the powder to a level surface. Place the petri dish on a clean transparency which is on the overhead projector. Have a pupil assistant who, at arm's length, drops water from a medicine dropper onto the powdered surface. Have pupils observe the pattern of the powder's image on the screen and the depressions in the surface of the powder in the dish.

5. Locate and identify for pupils the effects of erosion of soil in the school area or grounds if available. Trace the pattern of erosion from heavy rainstorm to the formation of gullies, and finally to the breaking away of large sections exposing roots of trees or bushes. Identify the trail of mud or soil left by the running water. Relate the ability of soil to hold water as affected by the plant life, porosity of the soil and incline of land.

6. Recall the demonstrations showing the action of glaciers and wind on the land. Ask "What is the source of energy for these agents of erosion?" Elicit that glaciers are part of the water cycle and the energy for this cycle is provided by the sun. Recall how winds are formed and the source of energy here is the sun too.

Summary:

1. Display pictures of the Grand Canyon. Explain how water formed the Canyon.

2. What energy forces are still at work in carving out the Grand Canyon?

Homework:

1. The sun provides the energy for the weathering and erosion of the land. Explain.

2. How are the coastlines of the continents being changed?

3. List evidences of weathering of buildings that you observe in your neighborhood.

Materials:

Glass jar
Towel
Sandstone
Beaker
Triple beam balance
Dilute hydrochloric acid
Limestone
Pictures showing eroded land.
Medicine dropper
Petri dish
Glass rod
Clean transparency
Overhead projector
Calcium carbonate

66. HOW DO LIVING THINGS HELP CHANGE THE FACE OF THE EARTH?

Outcomes:

. Living things produce substances which change the crust of the Earth.

. Living things change the earth's crust by mechanical and chemical action.

. Remains of dead plants in the soil prevent soil erosion.

Motivation:

Obtain and display a sample of soil containing such forms as earthworms, sow bugs, insect larvae and pupal and other living things. Ask pupils to look for living things in the soil sample. Have pupils suggest ways in which these living things that inhabit the soil may affect it.

Development:

1. Prepare the following demonstration two weeks in advance.
Fill 2 large boxes with sifted soil. Introduce earthworms into one box of soil. Use the other as a control. Permit pupils to make periodic inspections of the samples.
In class make a vertical section through each soil sample. Instruct the class to compare the soil profiles and to observe the following actions of the earthworms:

   1. loosening the soil

   2. transporting soil from top to bottom layers

   3. transporting soil from bottom to top layers

   4. aerating the soil

   5. contributing organic material to the soil

2. Ask the class to describe some of the weathering activities of plants. Point out such signs as weeds and tree roots growing out of cracks in the pavement. Direct pupil's attention to a section of a sidewalk (in the area of the school) lifted by the roots of a nearby tree. Stress the fact that these living things have made changes by mechanical action.

3. Trace the evolution of soil from a rock due to the action of living organisms.
   Display samples of rock with lichens and mosses. Show slides of rocks with higher forms of plants growing in the soil made possible by the action of lichens and mosses.

4. Have pupils examine lichens with a magnifying lens. Point out the rootlike threads that hold the plant to the rock. Ask "How do these threads help break down the upper portion of a rock into soil?" Elicit that these threads force their way into the tiny spaces of a rock and mechanically break down the rock. Point out that lichens produce chemicals which also serve to break down the rock chemically.

5. Prepare in advance of this lesson the following demonstration to show the production of acids from the roots of plants. Wet a thick piece of white blotting paper in a blue litmus solution. Place this between 2 pieces of glass. Place radish seeds between the paper and the glass and tie the pieces of glass together. Stand this setup in a pan containing a little water. Demonstrate the effect of acid on a blue litmus solution. Note the effect on the litmus as the plants grow. Ask "How might the acid produced by the roots of plants change the surface of the earth?" Note: Prepare a control setup without radish seeds.

6. Demonstrate the effect of dilute acid (hydrochloric) on a sample of limestone (or marble). Place the sample in a jar of dilute acid the day before this lesson. In class compare a similar sample of rock not placed in acid to the sample immersed in acid.

7. Demonstrate how humus, the organic remains of plants, affects soil structure. Display 2 battery jars, each fitted with a wire rack made from $\frac{1}{4}$-inch hardware screen. Prepare 2 lumps of soil (each about the size of an egg), one with a humus layer and the other without any humus. Fill each battery jar with sufficient water so that the racks holding the "egg-shaped" soil will be beneath the surface of the water. Have pupils observe and record the results. Elicit that the soil lacking in humus will crumble and fall to the bottom of the jar whereas the soil containing a humus layer will be almost unaffected by the water. Ask "How may water falling and running over soil lacking in humus affect this soil? Elicit that water falling and running over soil lacking in humus runs off instead of soaking in.

Summary:

1. How do earthworms change the soil they live in?

2. In what ways can plants break down rocks into soil?

3. How does a humus layer over soil prevent the removal of soil by water?

Homework:

1. How do lichens help change rock to soil?
2. What proof do you have in your neighborhood that plants can change the land surface?
3. How may chemicals produced by the roots of plants slowly change the earth's crust?

Materials:

Soil sample containing living organisms
2 Large boxes
Sifted soil
Earthworms
4 Glass plates
Blue litmus solution
Radish seeds
2 Pans
Test tube
Dilute bydrochloric acid
Rock samples with lichens
Magnifying lens
White blotting paper
2 Limestone samples
Medicine dropper
2 Battery jars
2 Wire racks
Soil deficient in humus
Humus

67. WHICH SOIL WILL HOLD MORE WATER?

LABORATORY LESSON

Outcomes:

. A soil's ability to hold water is dependent upon the spaces in the soil (POROSITY), and the materials in the soil that permit water to go through them (PERMEABILITY).

. Humus is soil containing the remains of dead vegetation.

Motivation:

Elicit pupils' experiences when walking over different ground covers after it has rained, i.e., gravel, sand, soil, forest floor.

Development:

1. Distribute worksheets and materials to each group of pupils.

2. Display the 3 samples to be tested: sand, powdered clay, humus. Define humus.

3. Demonstrate how to set up the glass funnel with a sample of sand. Place a small piece of metal gauze at the bottom of the funnel. Add sand to the funnel to within 2 inches of the rim.
Note: Dampen the funnel so that the material does not run through the tube. Ask "Why is a piece of gauze placed in the funnel?" Point out the need to add equal heights of all the samples to each funnel.

4. Place the funnel in the ring support. Add water gradually to the funnel. Record the time required for the water to reach the end of the tube. Stop pouring the water when it reaches the end of the tube. Tell the class that the permeability of the sample is tested in this way. Define permeability.

5. Cover the end of the tube of the funnel with a finger. Add sufficient water until the water covers and remains on the surface of the sand. Record the volume of water. Tell the class that the porosity of the sample is tested in this way. Define porosity.

Materials:

1 - Wide-mouthed funnel with long tube

1 - 100 ml graduated cylinder

1 - 200 ml beaker
1 Ring stand
1 Ring clamp
1 Piece of wire gauze

Sand
Powdered clay
Humus

Homework:

1. What should be the composition of a soil suitable for growing plants?

2. What effect will the addition of humus have upon soil?

3. What kind of ground dries out very quickly after a rainstorm?

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON 67

Problem:

Which soil material will hold more water?

Materials:

Ring stand

1 Ring clamp

1 - 100 ml. graduated cylinder

Sand

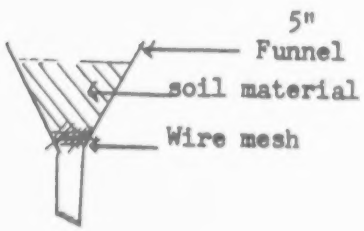
Powdered clay

Humus

3 - Wide-mouthed funnels with equal length tubes

3 Small pieces of wire mesh

1 - 200 ml Beaker



Procedures and Observations:

1. Attach the ring clamp to the stand.
2. Place a small piece of wire mesh at the bottom of each funnel.
3. Fill one funnel at a time with one of the samples to within 2 inches of the rim of the funnel
4. Support the funnel in the ring clamp. Place a beaker under the tube of the funnel.
5. Measure out 100 ml of water. Pour water gradually into the funnel.
6. Determine the time it takes for the water to reach the end of the tube. Repeat this procedure with each sample provided. Record the time required to fill the tube in the chart.

SAMPLE	TIME TO FILL TUBE
SAND	
CLAY	
HUMUS	

7. Replace each funnel with its contents in the ring support. Place an empty beaker under the funnel. Leave enough space between the end of the tube and the beaker so that a finger can be placed at the end of the tube.

8. Cover the end of the tube with a finger. Add water to each funnel until the water covers the sample. Record the volume of water required to cover and remain on the surface of the sample.

9. Remove your finger from the end of the tube. Collect the water in the beaker for 3 minutes. Measure the volume of water in the beaker. Subtract this volume of water from the volume of water added to the funnel. Record your observations in the chart.

SAMPLE	VOLUME OF WATER NEEDED TO COVER THE SAMPLE	VOLUME OF WATER COLLECTED IN THE BEAKER	VOLUME OF WATER HELD BY THE SAMPLE
SAND			
CLAY			
HUMUS			

Summary:

1. Which sample allows the water to pass through in the shortest period of time?

2. Which sample has the largest amount of space between its particles?

3. Which sample holds onto the largest volume of water?

4. Would any of these samples be a good soil for growing plants? Explain.

68. HOW DOES RUNNING WATER CHANGE THE ENVIRONMENT?

Outcomes:

. Many of the great changes on Earth are caused by running water.

. Running water carries away land materials from the continents. (Sediments include sand, pebbles, mud and shells.)
. The amount of material carried away by water and the sifting of fine and coarse particles is related to the speed and force of the running water.
Solar radiation and gravity supply the energy for running water.

Motivation:

Demonstrate the effect of running water on a container of sand. Prepare in advance a 3-sided heavy cardboard box, 2 feet long and 6 inches wide. Line the box with a heavy plastic sheet. Fill the trough half-way with sand. Raise the end with the short side and support it with a few wooden blocks. Place an aluminum dish at the other end of the trough. Bend down enough of the dish so that it can slip under the end of the trough for a distance of 2 inches. Make a hole at the opposite edge of the dish. Be sure that this part of the dish extends over the sink. A beaker placed in the sink will catch the excess water and any sand that comes through the opening. Connect a rubber tube to the faucet and place the opening of the tube on the surface of the sand furthest from the sink. Have a pupil assistant slowly turn on the water. Hold the tube in place and have the pupils observe what happens to some of the sand. Remove the blocks from the one end of the trough. Remove all water and sand from the aluminum dish and then place it under the trough again. Pour water directly onto the surface of the sand. Ask "What happens to the sand in the box? Why was more sand removed by the water when the box was tilted?"

Development:

1. Describe what the Grand Canyon may have looked like before the river created a deep canyon. Illustrate, with pictures or filmstrip, what the present Grand Canyon looks like. (Include picture of the Colorado River). Elicit how this river affects the land.

2. Ask the class "What changes has running water made in the parks you go to?" Point out evidences of recent erosion such as undercut ledges and gullies.

3. Direct pupils to observe the effect of running water on the soil where

new buildings are under construction. Call their attention to the narrow gullies where running water has carried away part of the soil.

4. Challenge pupils to trace the energy sources for running water. Recall the relationships of radiant energy, the water cycle and the effect of gravity upon water which is above sea level. Relate pupils' conclusions to the sources of energy for the Colorado River in the Grand Canyon. Use a large wall map to trace where the river begins and where it empties.

5. Assign pupils to explore the school grounds for evidences of the transportation of soil by running water. Focus their attention on the sediment that is often deposited along walks and low places on the school lawn. Ask "What materials does a river transport?" Define the term sediment and include its composition.

6. Prepare in advance 2 jars containing the same amount of water. Into one jar add a small quantity of sand and soil and a larger quantity of these materials to the second jar. Ask "Which jar of water would represent water taken from a river that was flooding the land? Explain." Discuss the effects of floods on the environment.

7. Perform the following demonstration to illustrate the deposition of materials as running water slows down. Add pebbles, colored gravel, coarse and fine sand, and soil to a large jar. Add water to the jar, cover it, and shake the contents of the jar to simulate running water. Allow the water to become quiet. Have pupils describe the settling out of materials as the water reaches a quiet stage. Indicate where this process is taking place wherever running water slows down. (ponds, lakes, oceans).

8. Recall that the earth is covered with rocks that were formed from sediments laid down in water. Guide the pupils to see this process as a constructive action of running water. Display and have pupils examine samples of sedimentary rocks.

Summary:

1. Why are some lakes and ponds disappearing all over our country?

2. How do the sun and the force of gravity create running water on earth?

Homework:

1. Describe some evidences of soil erosion in your neighborhood.

2. What happens to running water when it enters an ocean?

3. Why may the cost of food rise when some rivers in the United States flood the land?

Materials:

Wooden blocks
Heavy cardboard (box)
Tape
Heavy plastic
Sand
Rubber tubing
Aluminum dish
Beaker
1 Large jar
Pebbles
Soil
Gravel (colored)
Coarse sand
Pictures or slides of the Grand Canyon
1 Jar with small amount of sediment
1 Jar with large amount of sediment

69. HOW DOES THE SIZE OF PARTICLES HELP CREATE NEW LANDS?

LABORATORY LESSON

Outcomes:

. Materials that settle in water are called sediment.

. Usually larger rock particles tend to be at the bottom of a layer of sediment because they settle faster than smaller rock particles.

Motivation:

Use the cardboard trough from the previous lesson to demonstrate the deposition of sediment in quiet water. Line the trough with heavy plastic. Place the closed end on several blocks of wood so that the trough slopes toward a small glass aquarium. Add sand, gravel, pebbles and soil to the trough. Connect a rubber hose to the water faucet. Have a moderate flow of water enter the end of the trough supported on the blocks of wood. Pupils observe the water as it runs downhill into the aquarium. Ask "what is being built up in the aquarium?" Recall that a similar process occurs in ponds and lakes.

Development:

1. Distribute worksheets and materials to each group of pupils.

2. Guide the pupils in timing the rate at which a material, such as gravel, takes to settle to the bottom of a column of quiet water.

Materials:

Cardboard trough	Small glass aquarium
Wooden blocks	1 Liter graduated cylinder
Plastic liner	Rubber tubing
Sand	Soil
Gravel	Pebbles

Homework:

1. Why are pebbles, gravel, sand and mud usually unable to settle out in running water?

2. How might flood waters make the land more fertile?

3. What is building up at the mouths of rivers?

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET LESSON 69

Problem: How does the size of particles help create new lands?

Materials:

1 Liter graduated cylinder
Small containers of:
- coarse sand
- soil
- pebbles
- gravel

Stopwatch or clock with second hand.
Graph paper

Procedures and Observations:

1. Fill the graduated cylinder with water to the 750 ml. mark.
2. Place on a paper towel, in separate piles, a small amount of coarse sand, soil, gravel and a few pebbles.
3. Describe the size of one particle in each sample: very small, small, medium, large. Record your observation in the chart below.
4. Drop a small amount of each sample into the cylinder:
5. Record the time it takes each sample to reach the bottom of the cylinder. Repeat this procedure 3 times with each sample. Do not record the time for those particles which do not reach the bottom.
6. Calculate the average time it takes for the particles in each sample to reach the bottom of the cylinder. Record your observations on the chart.

Sample	Particle Size	Average Settling Time
Sand		
Soil		
Gravel		
Pebble		

7. When you have completed this investigation your teacher will assist you in graphing your results. Draw a graph. Plot the time it takes a particle to settle as compared to its size.

Summary:

1. Why must the water in the cylinder be kept still?

2. How does the size of particles usually affect the rate at which the particles settle in a quiet body of water?

3. A stream deposits sediment into a lake. Describe the size of the particles you would expect to find where the stream enters the lake. Explain your answer.

IV. MAN CHANGES THE ENVIRONMENT

70. WHAT IS POLLUTION?

Outcomes:

- Pollutants are waste material that may have a harmful effect on the environment.
- Materials that are pollutants in one environment may not be pollutants in another environment.

Motivation:

Display a collection of crumpled food wrappers, broken milk containers and other assorted waste materials. Ask the class to describe what they see. Pupils will most likely respond with words like "junk" or "garbage." Now show the same or similar materials in their original conditions. Once again ask the class to describe what they see. The materials may now be best described as containers or packages.

Development:

1. Establish that what we call materials depends upon their location and use. Used containers become litter.
2. Have the class collect and identify any litter in the class room.
3. Identify the litter as pollution in the class room. Label the waste basket as "Pollution Container."
4. Ask the pupils for other examples of pollution. List them on the chalk board and identify the source of each one.
5. Challenge the class to give examples of situations in which the pollutants can be put to a useful purpose.

Examples:

Pollutants	Not Pollutants
Garbage - litter	Used as landfill
Empty aluminum cans	Used to make new aluminum
Old newspapers	Recycled to make new paper

6. Elicit a definition of the term "pollution."

Summary:

Show film strip, slides or photos of waste litter. Have pupils identify various kinds.

Homework:

List all the kinds of pollutants that you find on the block where you live. What ideas do you have about cutting down on this kind of pollution.

Materials:

1. Collection of used containers and wrappers.
2. New containers and wrappers.
3. Film strip, slides, or photos showing pollution.

71. WHAT IS AIR POLLUTION?

Outcomes:

. Polluted air contains materials not normally found in air.

. Pollutants can be both particles and gases.

Motivation:

Coat a cotton swab with vaseline. With this swab, collect soot and grime from the outer window ledge. Show this to the class and ask the pupils to speculate what it is and where it came from. Identify the dirt as pollution.

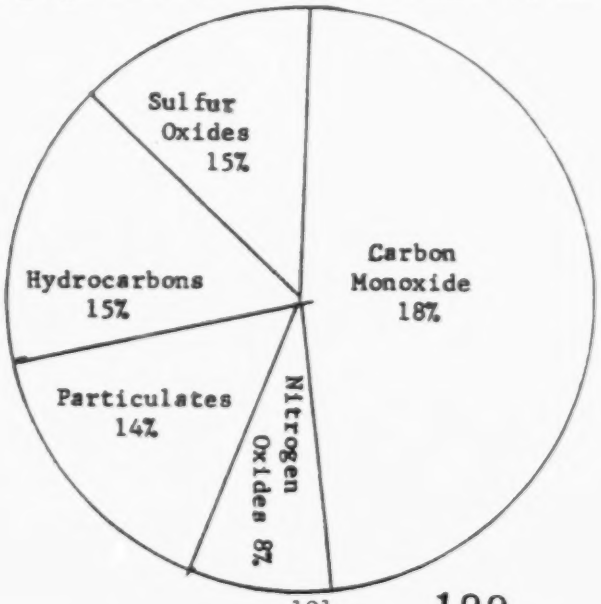
Development:

1. By means of discussion, the class may deduce that the pollution on the swab originally was carried by the air. Material such as this is not normally found in air. It is a form of air pollution. (Refer to the lesson on Composition of Air.)

2. Transfer some of the material on the swab to a microscope slide. Project it on a screen with a microprojector. Have the class describe what they see. (If time permits you may have groups of pupils make individual observations with the low power of the microscope.) Identify this material as matter and one type of air pollution.

3. Have pupils recall and describe the exhaust from a truck or bus. These gases are **not part of clean air.** They are examples of gases polluting the air.

4. Develop a circle graph showing the major elements of air pollution.



NOTE: Future lessons will discuss each component of air pollution in more detail. Pupils should begin to ask such questions as, "Where did it come from?" "How did it get into the air?" "How does it hurt us?" "What can we do about it?".

Summary:

1. How is polluted air different from pure air?

2. What is one source of gas pollutants?

3. Have the pupils make a drawing of a magnified view of particulate pollutants.

Homework:

1. Investigate particulate air pollution indoors and outdoors. Cut two cardboard squares (4 x 4 inches). Coat the top of the squares with a thin layer of vaseline. Place one on the inside of your window sill. Place the other outdoors. Leave them over night.

Questions:

1. Where is particulate air pollution greatest?

2. Why is the pollution greater in one place?

Materials:

cotton swab

vaseline

microprojector

glass slides

microscopes (optional)

72. HOW DOES OUR AIR BECOME POLLUTED?

LABORATORY LESSON

Outcomes:

- Some pollution comes from natural activities in the environment.
- Most air pollution comes from industrial processes and the automobile.

Motivation:

Show a film loop, film strip, film or slides of volcanic eruptions. Based on what they saw, ask "What pollutants might be added to the air by a volcanic eruption?"

Development:

1. With the pupils, identify the particulate pollution shown in the film of volcanic eruption.
2. Burn a very small amount of sulfur to produce sulfur dioxide (SO_2). Identify this as a polluting gas produced by volcanism.
3. Establish that volcanic activity is a natural source of air pollution.
4. Distribute laboratory work sheets to pupils containing Table of Major Sources of Air Pollution. Tell pupils they will be asked to analyze other sources of pollution.
5. Assist the pupils in reading the names of the pollutants listed on the worksheet table. Identify these gases as being irritating (affects eyes, nose and breathing passages) as well as poisonous.

DUPLICATE FOR USE BY PUPILS

LABORATORY WORKSHEET LESSON 72

Problem: Where does pollution come from?

Materials: Table of major sources of air pollution.

Procedures and Observations:

1. Use the information given in the table to answer the question listed below.
2. Write your answers on the worksheet.

New York Times (April 20, 1970)

SOURCES OF AIR POLLUTANTS, 1965

Millions of tons per year

Sources	Millions of tons per year	Percent of total	Carbon Monoxide	Sulfur Oxides	Hydro-carbons	Nitrogen Oxides	Parti-cles
Autos	86	60%	66	1	12	6	1
Industry	23	17%	2	9	4	2	6
Electric Power Plants	20	14%	1	12	1	3	3
Space Heating	8	6%	2	3	1	1	1
Refuse Disposal	5	3%	1	1	1	1	1
Totals	142	100%	72	26	19	13	15

Conclusions:

1. Where does the most air pollution come from?

2. Where does the least air pollution come from?

3. What produces the most hydrocarbon pollution?

73. HOW DOES AIR POLLUTION AFFECT LIVING THINGS?

Outcomes:

- Materials causing air pollution may injure living things.
- Materials causing air pollution may damage clothes and property.

Motivation:

To focus pupils' attention to the growing dangers of air pollution, conduct a neighborhood walk to provide first hand evidence of how our air is being polluted. On the walk, call pupil attention to:

- the sight and smell of exhaust from buses and autos.
- the discoloration of apartment buildings, trees.
- the haze in the sky.
- the changes in color of snow in winter.
- the deterioration of stone and marble monuments and building facades.
- the peeling of paint
- the smoke coming from apartment house chimneys and incinerators as well as from stores and factories.

Many excellent filmstrips are now available which depict some of these same scenes.

CAUTIONS

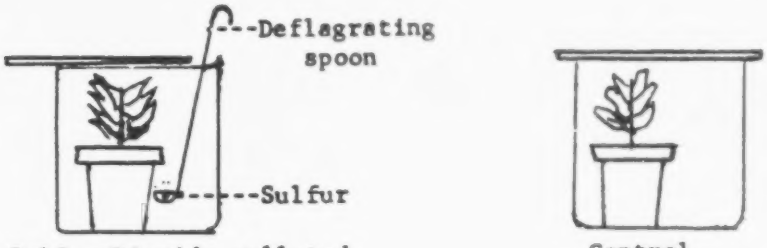
Burning sulfur produces an irritating and potentially dangerous gas-sulfur dioxide.

- Make sure this activity is conducted in a well-ventilated room. (see Science Safety K-12 manual 1971-72, #7.)
- Caution pupils against inhaling the gas.
- Use only a pinch of powdered sulfur.
- Perform this activity in the prep room first to become aware of any additional hazards.
- Check to see whether the fabrics can be bleached. Colored cotton fabrics are more easily bleached than artificial fabrics. Moisten the fabric slightly.

Development:

1. Investigate the effect of sulfur dioxide on foods and fabrics. Place apple skins, rose petals, moist fabric in a wide mouth jar. Ignite a very small amount of sulfur in a deflagrating spoon and burn it inside the jar. After the sulfur stops burning, withdraw the deflagrating spoon. Close the jar with a stopper or cover. At the end of the period, remove the fabric and allow the pupils to observe the bleaching affect of sulfur dioxide.

2. Investigate the effects of sulfur dioxide on living things. Obtain two small potted plants (bean seedlings will do). Place each of the plants in a small battery jar. Use sulfur and a deflagrating spoon to create an SO_2 atmosphere in one of the jar. Cover it quickly with a glass plate. Cover the other jar and use it as a control. Compare the condition of the plants at the end of the period and the next day.



3. Explain the effect of carbon monoxide on blood cells. Discuss locations such as tunnels and busy streets, where carbon monoxide levels may build up. Refer to the previous lesson to find the main source of carbon monoxide in air.

4. Sulfur dioxide forms an acid when it reacts with moisture in the air. To demonstrate its action on marble and building stone, add a dilute solution of sulfuric acid to marble chips. Observe the bubbling reaction. Relate this to some of the things the pupils saw in their walk. (NOTE: The process is much slower in nature than it is in the demonstration.)

Summary:

What might the effect of air pollution be on the following:
(1) bright red shirt (2) trees and shrubs (3) stone monuments.

Homework:

1. How does air pollution affect living things?

2. What affect does air pollution have on clothing and other materials?

3. In the demonstration of the effect of sulfur dioxide on plants, why was an extra jar used?

4. In what ways is air pollution costing people money?

Materials:

Sulfur
Deflagrating spoon
Matches
Wide mouth jar with stopper
Two small plants in pots
Two battery jars with glass plates

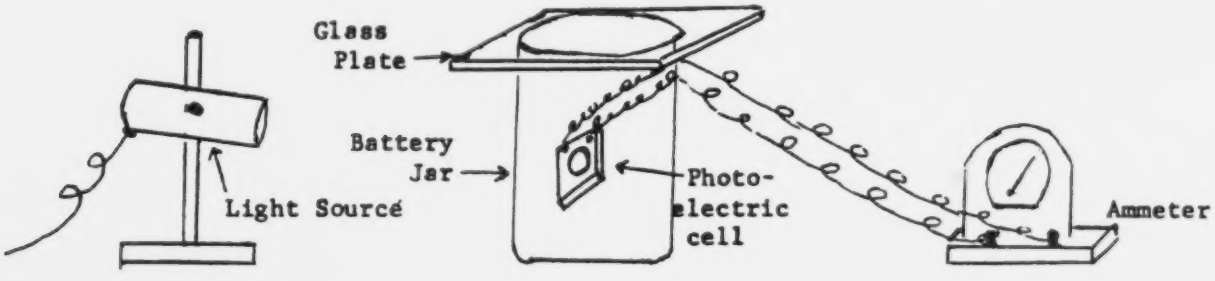
74. HOW CAN AIR POLLUTION CHANGE OUR WEATHER?

Outcomes:

- Air pollution reduces the amount of sunlight reaching the earth's surface.
- Smog tends to increase air temperatures.

Motivation:

Set up the following demonstration:



NOTE: A sensitive galvanometer will be necessary to measure the small amount of current generated. (A microammeter will register the small current generated by the photocell.)

Develop the following analogy with the pupils:

a. The light source represents the sun.

b. The air inside of the battery jar represents the earth's atmosphere.

c. The photo electric cell represents the earth's surface.

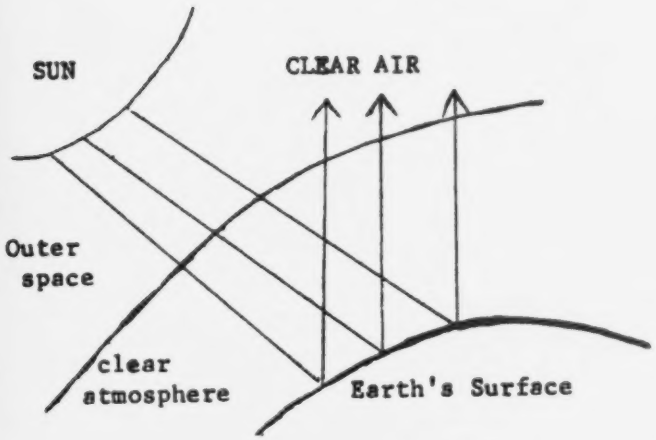
d. The ammeter shows how much light reaches "the earth's surface" (in our model).

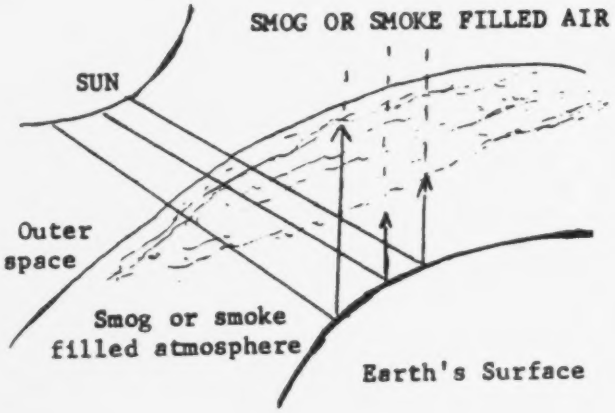
e. Measure the amount of light reaching the earth's surface (photo cell) with clear air. Using touch paper, fill the jar with smoke and repeat the measurement. Conduct a short discussion about the effect of smoke on sunlight.

Development

1. Show photos or slides of cities with dense covering of smoke or smog. Discuss what effect might this heavy smoke have upon the people in these cities? List suggestions on the chalkboard.

2. Heavy smoke or smog cover also tends to raise air temperature. Develop this concept with the following diagram:





Sunlight warms the earth's surface. When the atmosphere is clear, the energy can escape to outer space. When the atmosphere is filled with smoke or smog, the energy given off by the earth is absorbed by the atmosphere. The atmosphere becomes warmer.

3. Encourage pupils to speculate about the possible results of an increase in atmospheric temperature.

   NOTE: The results of overheating the atmosphere are <u>not firmly established</u>.

   Some of the possible results are:

   a. Decrease in snowfall.

   b. Increased discomfort due to high temperatures in the summer.

   c. Increased need for air conditioning leading to increased power consumption and additional pollution.

   d. The changed environment may not be suitable to local life forms.

   e. Power shortages.

Summary:

1. What affect does air pollution have on the sunlight reaching the earth?

2. How may air pollution increase the temperature here on earth?

3. Why is air pollution a greater problem now than in the past?

4. How can air pollution affect the weather?

5. What are the sources of air pollution in our community?

Homework:

1. How do you think life would change if the average temperature on earth went up 30° in the summer?

2. How do you think life on earth would change if the average temperature on earth were raised 30° in the winter?

Materials:

Light Source
Photoelectric cell
Battery jar
Glass plate to cover battery jar
Sensitive galvanometer
Touch paper

75. HOW DOES SMOKING POLLUTE OUR INTERNAL ENVIRONMENT?

Outcomes:

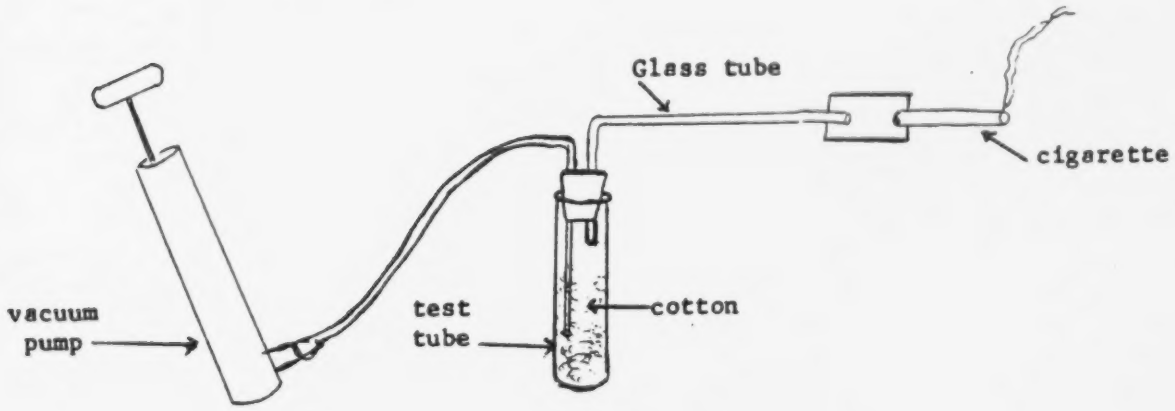
Cigarette smoking is dangerous to your health.

Motivation:

Review with the pupils the various forms of air pollution. Establish that most air pollution is due to burning and the production of smoke. Ask the pupils "Would any one like to have even more air pollution around them?" Display a package of cigarettes. Discuss the harmful affects of smoking.

Development:

1. Set up the "smoking machine" as shown in the illustration.



Use the pump to "smoke" the cigarette. Trace the path of the smoke through the machine.

2. Develop an analogy between the machine and the human respiratory system. Use a chart or model to show analogous parts.

cigarette holder	mouth
glass tube	throat and wind pipe
test tube	lungs

3. Disassemble and examine the parts of the smoking machine. Discuss the possible effects of the stains and tars on the human respiratory system.

4. Examine a cigarette wrapper. Read the surgeon's warning.

5. Discuss the relationship between smoking and lung and heart disease.

Summary:

Conduct a debate. Assign one team to give reasons not to smoke. The other team should try to defend smoking.

Homework:

1. Do a report on one of the following topics:

    a. Smoking and heart disease

    b. Smoking and lung cancer

    c. Smoking and emphysema

    d. How smoking tobacco began

    e. How to stop smoking

Materials:

Vacuum pump

Test tube

Chart or model of the respiratory system

2 hole rubber stopper

Cotton

Rubber tubing

Glass tubing

Cigarette (1)

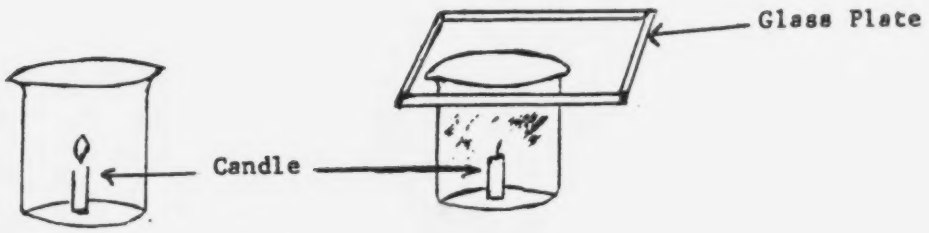
76. HOW CAN AIR POLLUTION BE CONTROLLED?

Outcomes:

- Air pollution can be controlled by reducing the production of pollutants.
- Air pollution can be controlled by removing pollutants.

Motivation:

Set up the demonstration shown below:



. Challenge pupils to account for the production of smoke in the covered beaker. When fuels are burned with too little air, pollutants are produced. Much of our air pollution is caused by burning.

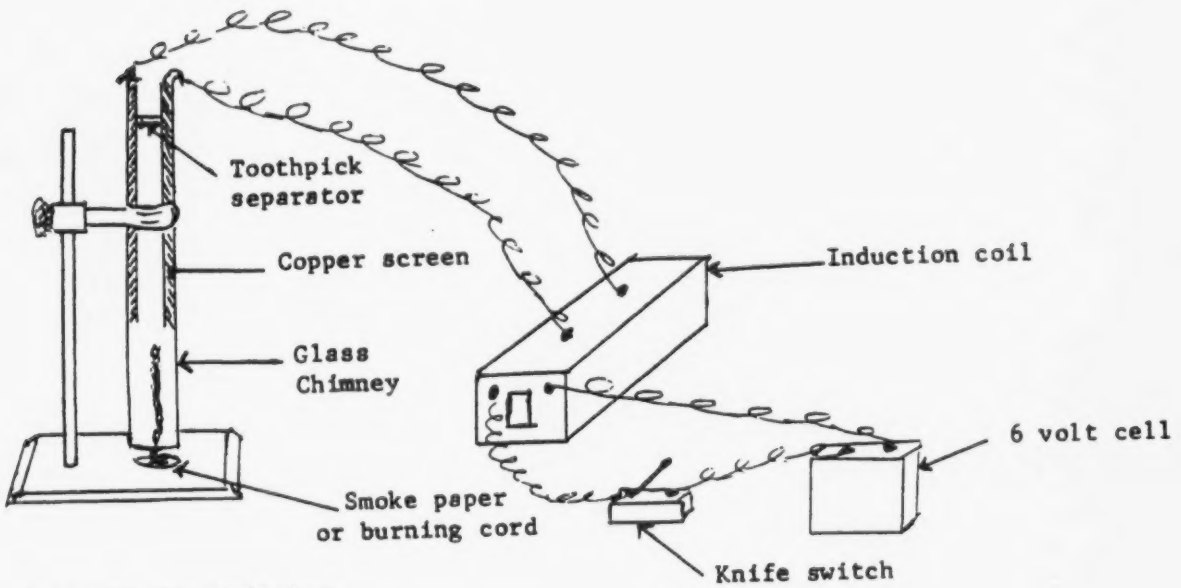
Development:

1. Most fuels are basically made up of oxygen, hydrogen, and carbon. Illustrate this with the aid of a table. Show examples of those fuels.

Fuel	Composition
Coal	Carbon
Gasoline	Hydrogen-Oxygen-Carbon
Alcohol	Hydrogen-Oxygen-Carbon
Propane	Hydrogen-Oxygen-Carbon

2. When some fuels are burned with enough air, less pollution is produced. To illustrate, burn a small amount of alcohol in a watch glass. Pupils will observe that little, or no smoke is produced. Compare this with the candle burning in the closed beaker.

3. Pollutants may be removed from air. Set up the following demonstration.



Cottrell Precipitator

When the coil is activated, the smoke will be quickly extracted (cleaned) from the chimney. This device is a model of a "Cottrell Precipitator."

4. Discuss and list possible uses of the "Cottrell Precipitator" for reducing the amount of pollution.

Summary:

1. List the different ways some air pollution can be prevented.
2. How can pollutants be removed from air?

Homework:

Make a short report on one of these topics:

1. Dr. F. G. Cottrell
2. Removing pollutants from automobile exhausts.
3. New laws about air pollution.
4. The sulfur in coal and oil.

Materials:

2 large beakers	Ring stand and clamp
2 small candles	Glass chimney
Glass plate	Strips of copper screen
Shade cord or touch paper	6 volt dry cell or power-supply
Knife switch	Toothpicks
Spark coil	Assorted wire for connections

77. HOW DOES WATER BECOME POLLUTED?

Outcomes:

- Added chemical and organic materials may pollute water

Motivation:

Introduce this lesson by asking the pupils to answer the question, "Why is water important to us?" Encourage pupils to suggest how water plays an important role in our lives. Note these suggestions on the chalkboard.

Some of the ideas suggested by the pupils should be:

- We obtain food from the water.
- We travel on the water.
- Waters of the oceans help keep the Earth's climate from becoming too hot or too cold.
- Ocean waters evaporate, form clouds, and fall as rain or snow.
- 90% of our body weight is water. We can live up to five weeks without food but only five days without water.
- Water, as perspiration, helps to cool our body and remove wastes.
- A great deal of water is needed to grow the plants that we eat.

Development:

1. Display a beaker of pure water. Also show some of the chemical poisons that have been identified as water pollutants:

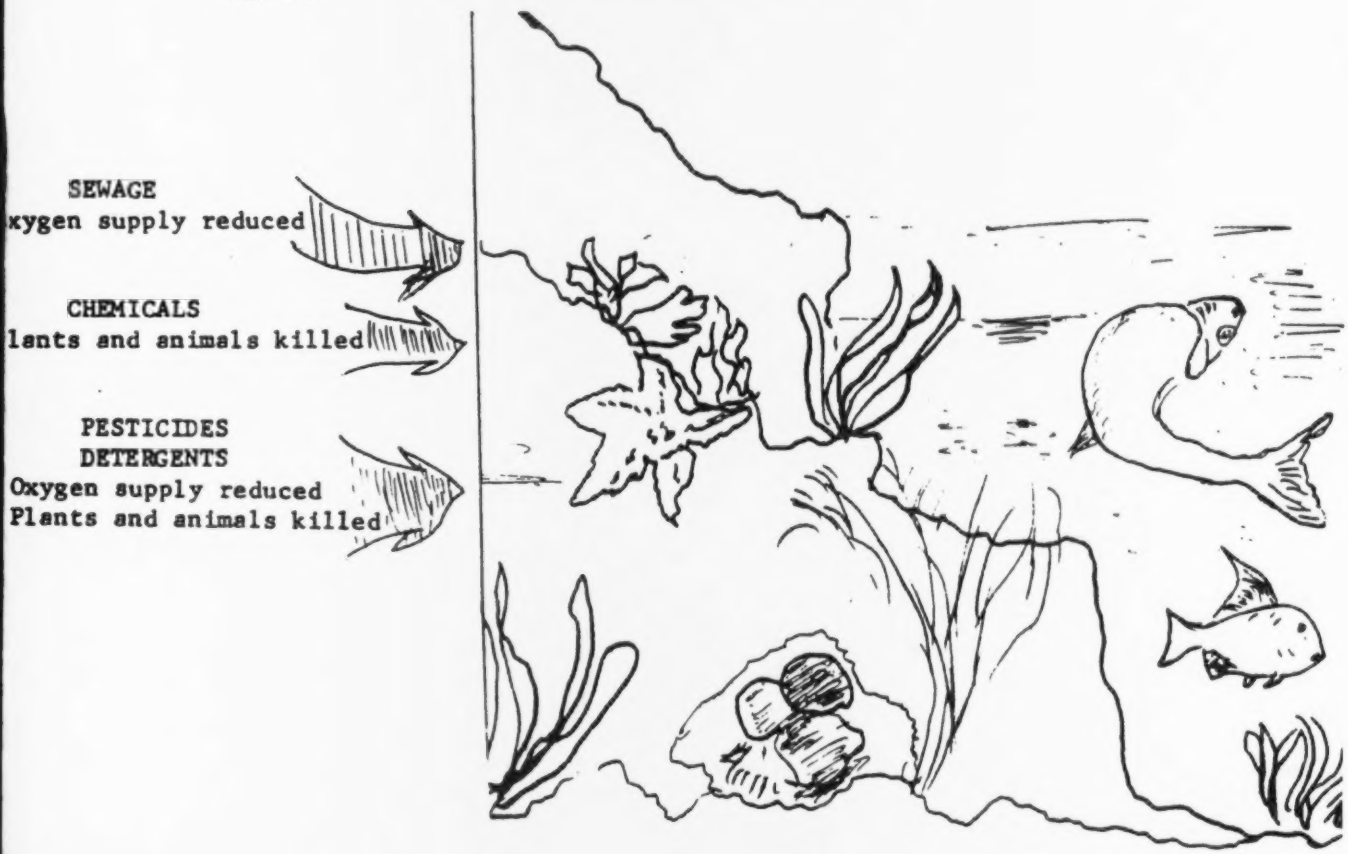
mercury	copper
some pesticides	iron
lead	oil
	phosphates (detergent)

Develop a chart showing how these materials get into water:

Pollutant	How It Gets Into The Water
Mercury Copper Lead Iron	Industrial waste
Oil	Oil spills
Pesticides	Spraying crops
Detergents	From washing machines and other cleaning processes.
Sewage	Dumping human and animal wastes into the water.

2. Show the effects of pollution on living organisms. Prepare a slide of mixed living protozoa (stock culture, pond water or fish tank water). Project the slide with a microprojector. Note the variety of living organisms present. Add a drop of copper sulfate solution. The living organisms will quickly die.

3. Use the diagram below to show how pollution can "kill" a body of water.



Show pupils photos or slides of water pollution. Have them list the possible causes of the pollution. Have the pupils describe the effects observed.

Homework:

1. In what way might washing dishes and clothing contribute to water pollution?

2. Swordfish have been found to contain the poison mercury. How could this happen?

3. What is the danger of having oil wells on the ocean floor?

Materials:

Samples of: Mercury,copper, lead, iron, oil, pesticides, phosphates

Mixed protozoan culture
Copper sulfate solution
Slides
Eye Dropper
Microprojector

78. HOW DOES THERMAL POLLUTION AFFECT WATER?

Outcomes:

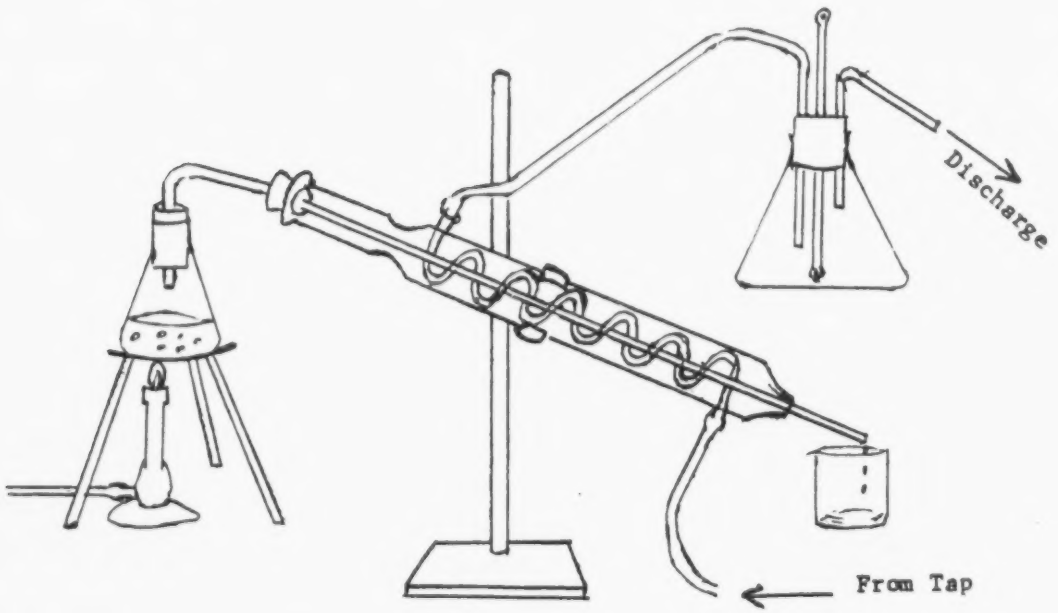
- Warm water cannot hold as much oxygen as cold water.
- Many fish and other animals that live in water cannot adjust to warm water.

Motivation:

Explain to the pupils that atomic power plants use large amounts of water. The water is needed to cool the steam used to drive the turbines. This water is very often taken from rivers. When the water is returned to the river, it is polluted. Challenge the pupils to suggest how the water may be polluted. Elicit that the water is heated, resulting in thermal pollution (see diagram under item 1c below).

Development:

1. Set up the following model to show how a power plant may add heat to water.



Start the water running in the cooling tube. Record its discharge temperature. Light the burner and run steam through the condensing tube. Once again record the temperature of the discharge water.

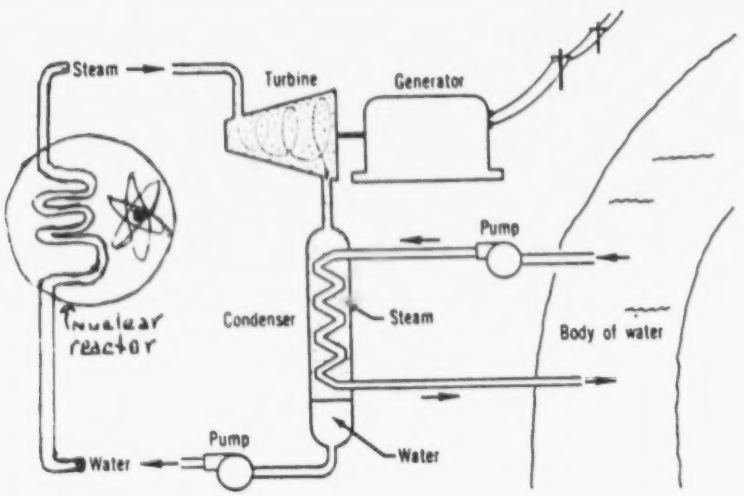
Note the rise in temperature.
Compare the model above to the real plant shown below:

a. The tap water represents fresh water from a river being pumped into a power plant.

b. The discharge water represents the water from the power plant pumped back to the river.

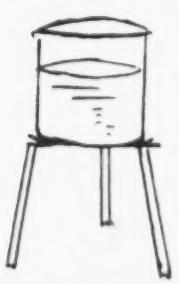
c. The condenser represents part of the power plant.

As the river water used to cool the steam runs through the power plant, its temperature is raised. It becomes <u>THERMALLY POLLUTED</u>.

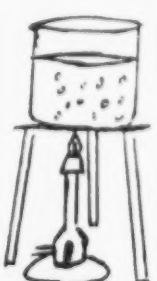


2. Ask, "Do fish need air as land animals do?" Explain that the gas, oxygen is needed by all living things. Fish get their oxygen from water. The oxygen (from air) is dissolved in the water. Thermally polluted water cannot hold as much dissolved oxygen as cool water. Fish in this water may die from lack of oxygen.

Set up the following demonstration to show that warm water cannot hold as much dissolved gases as cool water:



Cold Soda



Heated Soda

As soda water is heated the dissolved gases are given off. The cold soda, however, holds its dissolved gases.

NOTE: THE DISSOLVED GAS IN SODA IS CO_2. THE PRINCIPLE IS THE SAME FOR OXYGEN.

Another way to show this is to fill a beaker with cool water at the start of the lesson. Draw attention to the air bubbles that form as the water warms. This is dissolved air (containing oxygen) coming out.

3. Explain that fish and many other animals that live in water take on the temperature of the water they live in. As water temperature rises their body temperatures rise. This rise in body temperature may kill the fish or stop them from reproducing.

4. Other effects of thermal pollution are:

   a. Warm water encourages the growth of algae. The algae further reduce the amount of available oxygen in water.

   b. Fish may be attracted to warm water and then carried into the intake water ducts. This could kill large numbers of fish.

Summary:

A large electric company has built an atomic power plant on the Hudson River. Many people were opposed to the project. How might the power plant pollute the river? What harm may be done?

Homework:

1. How does heat pollute water?

2. What is water used for in atomic power plants?

3. How does thermal pollution harm fish?

Materials:

Condenser (Liebig)	3 hole rubber stopper
Tripod and stand	1 hole rubber stopper (2)
Bunsen burner	250 ml. flask (2)
Club soda	250 ml. beaker (3)
Thermometer	Assorted glass and rubber tubing

79. HOW CAN WE USE THE OCEANS WATER?

LABORATORY LESSON

Outcome:

Pure water may be prepared by distillation.

Motivation:

Have the pupils relate their experiences at the seashore. Ask if any pupil has even swallowed a mouthful of ocean water? "How did it taste?" Challenge the class to explain why sea water is not good for drinking?

Development:

1. Explain that the most abundant dissolved material in sea water is sodium chloride or salt. Dissolve some sodium chloride in water. Challenge the pupils to suggest ways that this salt water could be made pure again.

2. Distribute laboratory work sheets and materials to the pupils. Read the worksheet with the class and have them begin their exercise.

3. After the laboratory exercise, define the processes of evaporation and condensation.

4. Have the pupils examine the white residue in the beaker. Identify it as salt. The liquid on the watch glass is pure water. Elicit that the water was poiled away leaving the impurities behind.

5. Point out that removing impurities from water required heating. This in turn may produce some form of pollution.

Homework:

See laboratory worksheet.

Materials:

Alcohol burner
Salt water
Ring stand and clamp
Wire gauze pad
Beaker
Watch glass

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET - LESSON 79.

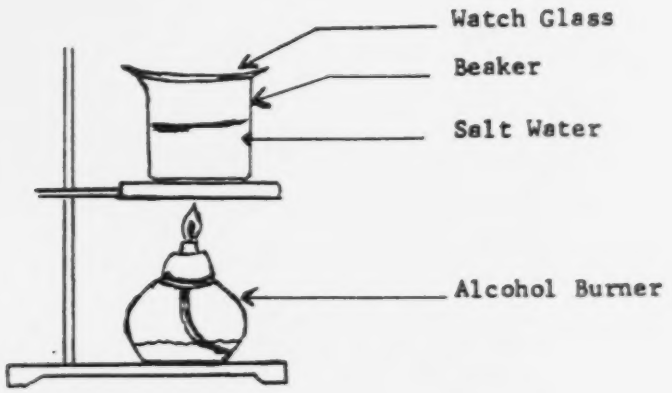
Problem: How can salt water be purified?

Materials:

Alcohol burner
Salt water
Ring stand
Clamp
Beaker
Wire gauze pad
Watch glass

Procedure:

1. Set up the apparatus shown below:



Pour about one inch of salt water into the beaker. Arrange as shown in the diagram.

2. HAVE YOUR TEACHER APPROVE YOUR SET UP. AFTER IT IS APPROVED YOUR TEACHER WILL LIGHT THE ALCOHOL LAMP.

3. Observe what happens as the salt water boils. Allow the water to boil until all of it is gone. Write down your observations below:

What happened in the beaker with the salt water?_____
_____
_____
_____

What happened on the watch glass over the beaker?_____
_____
_____

If you tasted a drop of water from the bottom of the watch glass, would it still taste salty?_____. Why?_____

Label one diagram - "EVAPORATION," the other - "CONDENSATION."

Homework:

1. What is evaporation?
2. What does sea water contain?
3. How can sea water be made pure?
4. How could evaporating large amounts of water cause pollution?

80. HOW CAN WE INCREASE THE USUABLE WATER SUPPLY?

Outcomes:

. Water supply can be increased by damming rivers and streams.

. Water softeners can make hard water fit to use.

. Water may be purified and reused.

Motivation:

Display two flasks, one filled with tap water, the other with tap water plus magnesium sulfate ($Mg\ SO_4$). Magnesium sulfate acts as a water "hardener". Label the flask with tap water - "Soft". The flask containing the water with $Mg\ SO_4$ - "Hard". Add a small amount of soap to each flask. Shake the flasks. Have pupils observe and note the results.

Development:

1. Define the terms "Hard" and "Soft" water. Set up a table to show some of the differences.

Soft Water	Hard Water
- Very little dissolved minerals.	- A great amount of dissolved minerals
- Makes good soap suds	- Makes poor soap suds
- Tastes good	- Has a strong taste

2. Show how hard water may be softened. Add a commercial water softener (such as Calgon) to a flask of hard water. Add soap powder and shake. Suds will now be produced. Water softeners can make hard water useful again. "Where would one expect to find hard water?"

3. Display a flask of muddy water. Show how filtering the water can remove the particles. This water may be reused after filtration. "Do you think it is safe to drink?"

4. Set up a Stream Table. Arrange for a central stream on the table to show how water runs down the stream to the sea and is lost for man's use. Construct a dam across the stream. Water now collects behind the dam. It is stored and used when needed.

Summary:

1. Have pupils prepare a table summarizing the ways in which the water may be made usable:

Unusable Water	Making Water Usuable
Hard water	Water softeners
Dirty water	Water filters
Stream and rivers run into the sea	Construct dams

Homework:

1. What is hard water?

2. What is soft water?

3. How can dirty water be cleared?

4. How can waters from rivers and streams be saved for man's use?

Materials:

Flasks (4)
Magnesium sulfate
Funnel
Filter paper
Beaker
Stream table
Muddy water

81. HOW DOES INCREASING POPULATION CAUSE POLLUTION?

Outcomes:

. An increase in population results in more wastes being produced.

. Increased population requires more energy. This causes increased industrial pollution.

. Increased population results in competition for available space and supplies.

Motivation:

Recall, from lesson #3, the effect of overcrowding as illustrated by having more pupils moving into a large circle. Repeat, if necessary, to reinforce the stress placed on individuals involved. If available, show a film, filmstrip or magazine picture which illustrate urban overcrowding.

Note: Various demonstrations, in addition to those suggested in this lesson should be prepared in advance permitting long-term observations:

- overstocking small jar with brine shrimp
- observing behavior of small fish in overcrowded tank

Development:

1. List the observed effects of overcrowding. Relate pupil experiences to conditions in crowded city environments. Use examples such as crowded buses and subways to conclude that the competition for space strongly affects the individual in many ways.

2. Discuss with the class the consequences of supplying a crowded city, such as New York, with food and fuel. "How would overcrowding also result in air and water pollution?"

3. Introduce a discussion of the New York City sewerage system by challenging the pupils with a question such as, "Did you know that there are thousands of miles of streams under New York City?" As population is increased more waste is produced. This leads to increased pollution. Display photographs of new sewerage disposal plants to show how cities attempt to cope with this problem.

4. Discuss with the pupils the results of supplying a large crowded city with energy. Refer to past lessons to reinforce the concept that the production of energy results in pollution problems.

5. Prepare the following projects for long-term observations:

   a) After soaking, place a large number of lima bean seeds in one pot and a few beans in another. Have pupils note differences in the growth patterns of the beans in each pot. Observe for length and rigor of stems, color and feel of leaves and survival rate of the beans compared to the number planted.

   b) To two similar jars add a large number of mealworms to one jar and a few to another jar. Mealworms may be purchased at any aquarium store. Culture the mealworms by adding bran or oatmeal. Cover the jars with a fine mesh to prevent adult beetles from flying off. Again, have pupils observe and note developmental differences and survival rates between the two jars.

   c) Excellent population studies may be carried out with other diverse forms as:

      - Paramecia (easily seen with a 10 X hand lens)

      - Daphnia - purchase at aquarium store

      - Cyclops - (crustaceans from ponds and lakes)

      - Brine shrimp (Artemia) purchased at aquarium stores.

      - Pill bugs and sow bugs - found under small rocks and logs. Feed bits of apple, lettuce and carrots. Keep in moist soil

      - Snails - refer to standard reference books for care and maintenance of organisms listed above

Summary:

1. Set the class up for a debate. Assign one team to give reasons for living in a crowded city. Assign the other to give reasons for living in the country.

Homework:

1. What happens when too many living things are crowded together?
2. How do large cities get rid of the waste products from the population?
3. How does supplying a large city with energy cause population?
4. What experiment could you set up to find out the effects of overcrowding on plants?

Materials:

Seed trays	Radish Seeds
Soil	Dish

82. HOW CAN SOUND CAUSE POLLUTION?

LABORATORY LESSON

Outcomes:

. Sounds may cause discomfort to humans.

. Sounds may damage the ear.

SPECIAL NOTE:

The laboratory experience described below involves pupils listening to taped recordings of different sounds. In this exercise, the pupils will rate each sound according to the scale included on the worksheet.

The tape for this lesson must be planned well in advance. Sounds should be recorded both indoors and outdoors. Suggested sounds are:

OUTDOORS	INDOORS
Truck	Loud radio
Bus	School cafeteria
Pneumatic drill	Classroom in use
Thunder storm	Gym in use
Subway train	Empty room
Pounding surf	Music - loud rock
Building construction	Music - soft
Jet plane take-off	Electric saw in wood shop

Motivation:

Before class begins, enlist the aid of a group of eight pupils. Tell them that as you begin the lesson, they are to recite the multiplication tables in a low speaking voice. They are to begin as you begin and continue until you tell them to stop.

Start the lesson with a normal tone of voice. Increase your loudness to overcome the talking of the pupils. After a short time instruct the pupils saying the multiplication tables to stop talking. Conduct a short discussion of the effect of unwanted sounds or noise. Introduce the term "noise pollution."

Development:

1. Explain to the pupils some of the physical and psychological effects of noise:

    a. Temporary or permanent hearing loss.
    b. Headaches

c. Fatigue
d. Irritability
e. Loss of efficiency at school or at work.

2. Distribute the laboratory worksheets. Read the worksheet with the pupils and have them begin the exercise. Give special attention to the use of the numerical noise scale.

3. Play the prepared tape. Allow sufficient time for pupils to respond to each sound.

4. Encourage the pupils to identify the various sounds on the tape.

5. Discuss how those sounds rated "Very Noisy" and "Extremely Noisy" might pollute the environment.

6. Encourage pupils to describe their feelings and reactions to the unpleasant sounds.

7. Elicit from the class ways in which noise pollution might be reduced:

a. Sound proofing
b. Mufflers on trucks, buses and cars
c. Bans on jets over cities
d. Anti-noise laws

(DUPLICATE FOR USE BY PUPILS)

LABORATORY WORKSHEET LESSON 82.

Problem: How can sound cause pollution?

The teacher will play a recording of some sounds. Listen to them carefully and fill in your observations on the chart below. Rate the sounds based upon the following scale:

NOT NOISY		LITTLE NOISE			VERY NOISY		EXTREMELY NOISY	
1	2	3	4	5	6	7	8	9

Sound	Where the Sound Comes From	Noise Level
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Sound	Where the Sound Comes From	Noise Level
16		
17		
18		
19		
20		

Conclusions:

1. What kinds of sounds are most noisy?
2. What kinds of sounds are least noisy?
3. How could very noisy and extremely noisy sounds harm or pollute the environment?
4. How could very noisy and extremely noisy sounds be reduced?

83. WHAT IS SOLID WASTE POLLUTION AND HOW CAN IT BE RECYCLED?

Outcomes:

. Solid waste requires large amounts of space for disposal.

. Solid waste pollution can be reduced by recycling.

Motivation:

Cut out an advertisement for a home trash compactor. Show the "ad" to the pupils. Challenge them to explain how a trash compactor might assist in the disposal of solid waste.

Development:

1. Display examples of solid waste that might easily become pollutants:

   a. glass bottles
   b. plastic bottles
   c. aluminum cans
   d. orange peels
   e. old newspspers

2. Challenge the pupils to give ways that each of the above might be disposed of without causing pollution. Set up a table like the one below:

Solid Waste	Proper method of disposal
Glass	Most glass containers may be reused.
Plastic	*Present methods are unsatisfactory.
Metals	Remelted and used again.
Food	Allowed to decay underground, or burned.
Paper	Recycled to make new paper.

3. Demonstrate how food may be reduced in volume and weight for easier disposal. Weigh some orange peel in a covered crucible. Heat well with a bunsen burner for about five minutes. Weigh the crucible and contents again and calculate the weight lost. Display the contents of the crucible If time permits, continue heating until only a fine ash remains. Heating at high temperatures makes disposal of solid food waste much easier.

4. Bring photos (or film strips) of sanitary land fill areas to show how solid waste is disposed of underground. Since there is limited space for these land fills, then reduction of volume of solid waste is vital.

5. Display a pamphlet printed on recycled paper. Ask the pupils to explain how this might reduce solid waste pollution.

Summary:

List eight things in the home that might cause solid waste pollution when disposed of.

Homework:

1. What is the best way to dispose of glass bottles?

2. What very common material is very difficult to dispose of?

3. How can solid food waste be reduced in volume and weight?

4. What use can be made of waste or scrap metal?

5. What good use can be made of old newspapers?

Materials:

Assorted samples of solid waste
Orange peels
Crucible with cover
Triangle
Bunsen burner
Tongs
Tripod
Carbon block
Lead oxide
Blowpipe

84. HOW CAN MAN INCREASE HIS FOOD SUPPLY?

Outcomes:

. Special methods of farming lead to increased crops.

. The oceans may be farm lands in the future.

Motivation:

Establish that one vital ingredient for production of crops is water. Set up a stream table with terraces. Show that more water is retained with the terraces. This allows more efficient farming on hillsides and results in increased crop yield.

Development:

1. Define the word terrace. Show photos of terraced farm lands. Briefly review how each of the following contribute to increased farm yields:
   Contour plowing, control of plant diseases, irrigation
   Alternation of crops, control of insects, wind control (trees)

2. Special seeds have been developed to grow under varying conditions. Display a special catalog. Have pupils read the descriptions of the different types of corn, beans. "How does seed selection help improve the yield?"

   Two examples are given below:

   Peppers:

   Allbig Variety - early maturing, suitable for northern climate and soil.

   California Wonder Variety - summer maturing, acid soil, suited for hot, moist climate

   Florida Giant Variety - suitable for southeastern climate, longer maturity period, thrives in hot weather.

   Lettuce:

   Caravan Variety - cool season crop, late spring maturity, suitable for costal soil (California)

   Great Lakes Variety - late summer maturity, grows well on mineral soil, requires moist climate.

   Number 456 Variety - for summer harvest, grows well on muck and heavy soils of Northeast, resistant to heat, susceptible to frost injury.

3. Set up a long range project. Plant several types of the same kind of seeds in a single tray. See which grow best under local conditions.

4. Set up a long-range investigation. Plant bean seeds in two separate pots of sand. Add water to one pot. Water the other with fertilizer added. "What effect does adding nutrients to the soil have on the growing plants?"

5. The oceans serve as a huge resource for food productions. Fifty-five million tons of food are taken from the oceans each year. In addition to the fish industry, discuss various other methods of sea farming. An excellent example is oyster farming. Almost all of the natural oyster beds in our area have vanished. Oysters are now "planted" in bays and later harvested.

6. Show a film strip dealing with ocean farming and obtaining food from the sea. Discuss the possibility of using different sea weeds as food. This is now done elsewhere in the world (Japan). If possible, purchase from a health store and display samples.

7. Refer to the lessons dealing with water pollution. Discuss the need to preserve our oceans in a clean unpolluted condition.

Summary:

Develop a chart showing how man's food supply may be increased.

Activity	How It Helps
FARM PRODUCTS	
1. Terrace sloping land	1. Holds and conserves water
2. Add fertilizers	2. Provides nutrients for plants
3. ---7	3. ---7
SEA PRODUCTS	
1. Planting seaweed	1. Selecting the type of seaweed which grow best under varying conditions
2. ---4	2. ---4

Homework:

1. How can crops be grown on steep hill sides?

2. Why do seed catalogs offer many different types of bean seeds?

3. Why do farmers add fertilizer to the soil?

4. What kinds of crops are grown in the sea?

Materials:

Stream table Seeds Seed catalog Film strip on ocean farming

85. HOW CAN FORESTS BE CONSERVED?

Outcomes:

. We must practice conservation methods to maintain our forests.

. Recycling paper is one way of conserving wood.

Motivation:

Display photographs or film strips of areas that have been deforested. Challenge the pupils with the question "What would our country be like if all the forests were gone?" Establish that the forest is the home for much of our wildlife. Also, the forest is our only source of wood for building and paper. "Why are forests and woodlands important for recreation?"

Development:

1. Discuss with the pupils the effect of deforestation. Define erosion and relate the movement of the soil with the loss of trees and plant life.

2. Discuss the role of lumber companies in maintaining the forests. As trees are harvested others are planted to take their places. Show photos of replaced forest areas.

3. Show the class slides on photos of burned forest land. Elicit how forest fires contribute to the destruction of woodlands and wildlife.

4. A large portion of the trees cut down are used to produce paper. If paper can be reused, forest trees will be conserved. Demonstrate recycling of paper.

   a. Prepare a newspaper soup in advance

      Tear one square foot of newspaper into small pieces. Soak this paper for at least one hour in a 1/4 filled bowl of water.

   b. Explain how you prepared the newspaper soup. Blend the paper with the water until the paper fibers separate. A hand beater or an electric mixer should be used for this purpose.

   c. Add two tablespoons of starch to this mixture and stir well.

   d. Dip a wire gauze square into the mix. Repeat this until a 1/16 inch layer is built up on the gauze.

   e. Place a layer of newspaper on the table. Place the wire gauze

and paper, screen down, on the paper pad. Place a square of plastic food wrap over the gauze square and a block of wood over the combination. Press down on the wood block to remove excess water from the recycled paper.

Display the recycled paper to the class. Put it in a safe place for complete drying. At the next lesson, show the class the finished dry recycled paper.

Summary:

1. Have the pupils fill in a chart with headings as shown below:

Use of Forests	Ways to Conserve our Forests	Things that Destroy the Forest

Homework:

1. How does deforestation affect the land?
2. What is a natural cause of deforestation?
3. How does recycling paper help conserve our forests?
4. What is one way to restore deforested areas?

Materials:

Newspaper
Wire Gauze
Starch
Plastic wrap
Wooden block
Mixer or beater

86. WHAT ARE ENDANGERED AND EXTINCT SPECIES?

Outcomes:

- Many species of animals have been made extinct by the activities of man.
- Many species of animals have become extinct by natural processes.

Motivation:

Obtain and display a photograph of a passenger pigeon. Explain that the last passenger pigeon's body is now in the National Museum in Washington, D.C. This is the sign over its body.

MARTHA

Last of Her Species
Died: 1:00 p.m. 1 September 1914
Age-29 in the Cincinnati Zoological Gardens
-EXTINCT-

Explain that at one time there were millions of passenger pigeons. The last wild passenger pigeon was seen in Wisconsin in 1899. Fifteen years later Martha, the last passenger pigeon died in the Cincinnati Zoo.

Refer to the picture of the bald eagle on the back of one-dollar bills. This bird, a national symbol, is on the endangered species list also.

NOTE:
There is abundant literature dealing with species that are identified as "extinct" or "endangered." To extend the investigation of this sensitive area beyond the boundries of this lesson, the teacher may wish to refer to these agencies requesting their publications:

National Wildlife Federation
Friends of Animals
Sierra Club
National Audubon Society
American Museum of Natural History

Development:

1. Explain the meaning of the word "extinct." Ask the class to express their reactions to the extinction of the passenger pigeon. "Why does the extinction of one species diminish us all?"
2. Elicit possible reasons for the extinction of the passenger pigeon:
   a. Development of efficient ways of trapping large numbers of birds.

b. Used as food

c. Lack of public interest in the preservation of the species

d. Hunted for sport

3. Discuss and show photographs (if available) of other well known recently extinct species such as:

a. Dodo bird

b. Eastern timber wolf

c. Ocean mammals (Sea Cow)

4. Develop with the pupils ways in which a species may become extinct because of man:

a. over killing

b. poisoning their environment (including pesticides)

c. destroying breeding grounds

d. destruction of their food supply

e. destroying or reducing their natural enemies

f. loss of living space due to the expansion of man's activities

5. List some species that are not yet extinct, but are in danger of becoming extinct. These are called "Endangered Species:"

a. Some kinds of whales, seals

b. Leopard, cheetah, jaguar, tiger

c. Rhinoceros

d. Alligator

e. California condors

f. Polar bears

Discuss reasons for the endangerment of these species and ways to protect them. Use photos or slides to show the animals.

6. Explain that many species have become extinct due to natural processes; the outstanding example is the dinosaur. Show photos or models of dinosaurs. Discuss possible reasons for their extinction as for example:

a. inability to adapt to changing environment

b. lack of sufficient food

c. disease

Summary:

1. What is an extinct species?

2. What is an endangered species?

3. What are some of the reasons for a species' extinction?

Homework:

1. Go to the library and do a report on one of the following topics:

   a. Endangered and extinct species

   b. Why the Dinosaurs Became Extinct

   c. How the American Bison Was Saved From Extinction

   d. African Wild Life Preserves

   e. The Dodo

   f. The Passenger Pigeon

   g. The Whooping Crane

Materials:

Photos on slides of:

Passenger pigeon	Timber wolf	Dinosaurs
Dodo	Alligators	
Leopard	Whales	
Rhinoceros	California Condor	

87. HOW CAN WE CONSERVE OUR WILDLIFE?

Outcomes:

- A community (local and governmental) passes "game laws" to protect our wildlife.

- National parks are established to provide a safe place for animals to live.

Motivation:

Obtain a copy of the New York State fish and game laws. This is available where hunting and fishing licenses are sold. Read through some of the regulations dealing with size and seasons. Challenge the pupils to explain how these laws will help conserve our wildlife.

Development:

1. Laws have been developed that protect our wildlife. Explain that many endangered species such as the California Condor and Whooping Crane may not be hunted.

2. Hunting and fishing seasons have been established. Explain that many fish spawn in the early spring. Challenge the class to designate a "closed season "for these fish and give reasons for their choice.

3. New York State sets a limit to the number of trout that a fisherman may keep each day. Have the pupils give reasons for this limit. (Leave enough to spawn.)

4. Discuss with the pupils the problems of conservation of ocean life. Refer to the present dispute over territorial fishing waters. Twelve miles was the old limit. Many countries would like to extend this to 200 miles. Call attention to the difficulty of enforcing conservation laws on the oceans.

5. Explain the concept of a National Park or Game Preserve. The U.S. National Parks are excellent examples. In Africa there is the Serengetti National Park. In these designated areas, no hunting for sport is permitted. Animals may be hunted by game wardens to keep populations in balance. Show photos, slides or films of National Parks and the "protected animals."

6. Discuss the idea of a national sea shore. This is an ocean front that is kept in an undeveloped condition. It assists in the preservation of the salt water marshes and dunes. The marshes and dunes are

places where many fish and birds nest or spawn.

Summary:

Show photos of various protected fish, birds, and animals. Have the pupils explain how each is helped by these conservation efforts.

Suggested Trips:

1. Jamaica Bay Wildlife Preserve - Queens
2. High Rock - Staten Island
3. American Museum of Natural History - Manhattan
4. Brooklyn Aquarium - Coney Island, Brooklyn
5. Bronx Zoo

Homework:

1. Why are there "closed seasons" on many fish and animals?
2. Why is it against the law to hunt for Whooping Cranes?
3. Why are conservation laws difficult to enforce at sea?
4. How do National Parks and Seashores help preserve our wildlife?

Materials:

Copy of N.Y.S. Fish and Game laws
Photos-slides-films of national parks

88. HOW CAN WE IMPROVE OUR LOCAL ENVIRONMENT?

Outcome:

. We must become actively involved in making our environment a better place to live.

Motivation:

Challenge individual pupils in the class to think of ways in which they as individuals can help to improve the local environment.

Note:

This lesson is devoted to the development of activities within the school and community, to deal with local problems in the environment. It is the last lesson in the syllabus and should be extended as time permits. Thirty five millimeter slides take of the activities in this lesson easily could serve as the basis for an excellent auditorium program for the school.

Development:

1. Organize the class into four committees. Each committee should examine the conditions and devise a plan to improve one area of the local environment. Encourage pupils to use various references. In addition, they should also use their notes taken during previous lessons. The four areas that might be considered are:

   I. Fighting pollution and helping the environment in the home.

   II. Fighting pollution and helping the environment as we shop.

   III. Fighting pollution and helping the environment outdoors.

   IV. Fighting pollution and helping the environment in our school.

2. Move from committee to committee making suggestions as needed. Some ideas that may be considered by the various committees are:

   I. In the home:

      1. Saving water.
      2. Saving electricity.
      3. Wasting less paper.
      4. Recycling re-usable containers.
      5. Checking the furnace and fuel used.
      6. Proper disposal of garbage.

   II. As we shop:

      1. Buy items packaged in returnable containers.
      2. Avoid high phosphate cleaning products.
      3. Do not buy products made from animals on the endangered list.

III. Outdoors:

1. Proper use of pesticides.
2. Planting and protection of trees and plants.
3. Use of mass transit instead of automobiles.
4. Collection of waste materials for recycling.
5. Set up of block associations to help clean up and maintain small areas.
6. Notify proper department of abandoned cars, improper storage of garbage, abandoned buildings, etc.

IV. In the School:

1. Be sure desks and floors are always kept clean.
2. Check the schools heating system. Find out what type of fuel is used.
3. Check for proper disposal of waste from the school cafeteria.
4. Make a general tour of the school building in co-operation with the custodian. Does the school contribute to pollution?

3. Have each of the committees report its plan to the class. Discussion of plans should be encouraged.

4. Carry out as many of the committees plans as are possible. Photograph each of the activities for future discussion and evaluation. These photos may also serve as motivation for the following term.

5. In your classroom conduct an evaluation of how well the committee's plans worked. Stress positive results and accomplishments.

6. Develop bulletin displays in school to show the efforts of your class to improve the local environment.

7. Use the 35 mm slides you have taken to prepare an auditorium program based on your classes efforts to improve the local environment. Invite members of local environmental action groups to speak at this auditorium program.

Summary and Homework:

Prepare a report showing how your committee helped improve the local environment. Explain the problems you faced and how you solved them. Tell what you think should be done in the future to improve the local environment.

Materials:

35 mm camera or polaroid camera

An Environmental Community Program

A suggested long-term approach which would also consider concomittant problems growing from or contributing to environmental degredation is as follows:

WHAT ARE THE PROBLEMS?

Identify some of the problems in the community as for example:

1. What's wrong with our community?
2. Why do people start taking drugs? How do drugs affect our health? How does our community contribute to the growth of drug use?
3. Why is there so much noise in our area?
4. How do open garbage cans, garbage in the street and garbage dumped in vacant lots contribute to poor health in the community?
5. How does an open or broken fire hydrant hurt us?
6. How can we get more play areas?
7. How can we prevent fires?
8. How can we improve the appearance of our community?

HOW DO WE FIND OUT?

1. Survey to develop a community profile:

   Abandoned or fire gutted houses.
   Broken sidewalks
   Potholes
   Garbage
   Empty lots
   Broken fire hydrants
   Vermin infestation, Abandoned Animals.
   Abandoned cars

2. Conduct interviews and opinion polls in the neighborhood.
3. Take pictures and slides of what you see and record in your notes.
4. Write to Resource Agencies for information and booklets to help you find out more about your subject.*

   Sierra Club - 15 East 53rd Street, New York, NY
   N.Y. Lung Assoc. - 15 East 26 St., New York, N.Y.
   N.Y. State Action for Clean Air - 105 East 22 St., New York, NY
   N.Y.C. Dept. of Air Resources - 51 Astor Place, New York, NY
   Audubon Society - 1130 5th Avenue, New York, NY
   Brooklyn Botanic Garden - 1000 Washington Ave., Brooklyn, NY
   Citizens For Clean Air - 502 Park Avenue, New York, NY
   Citizens Committee to Keep N.Y.C. Clean - 51 Madison Ave., New York
   Environmental Action Coalition - 235 East 49 St., New York, NY
   Operation - Better Block - 51 Chambers St., New York, NY
   Metropolitan Council on Housing - 2 W. 31 St., New York, NY
   Department of Sanitation - Community Service - 125 Worth St., New York

* Addresses shown are as of date of issue. Consult a directory for current changes.

Parks Council - 80 Central Park West, New York, NY
Friends of the Earth - 30 East 42 St., New York, NY
Citizens For A Quieter City - 136 East 57 St., New York, NY
Addiction Control Commission - Albany, NY
Addiction Services Agency - 71 Worth St., New York, NY

WHAT DO WE DO?

1. Prepare reports, pictures, slides, charts and graphs based on findings.
2. Develop class and school information bulletin, handbook and circulars to publicize findings and suggestions.
3. Start a school-wide action program which will involve as many pupils as possible - recycling (bottles, cans and paper) or clean up so as to create a model for the community.
4. Create an Environmental Awareness climate in the school by preparing displays and bulletin board exhibits dealing with problems in the community environment:

   Making toys from usable materials
   Photographs of vacant lots and rubbish
   Clean-up campaigns
   Planting activities
   Identifying streets with abandoned cars, garbage, etc.
   Recycling centers

5. Develop and distribute guides dealing with ways pupils can make contributions to the program in the school, at home and in the community.
6. Plan for various contests (essay, photo, reporting, displays and projects) and enlist aid of organizations in presenting awards.
7. Hold assembly programs involving pupil activities and talks by representatives of various city agencies.
8. Cooperate with the community in helping to establish or extend the activities of Block Associations and Community Action Committees.
9. Organize writing campaigns alerting city agencies of problems in the area:

   Water Problems - N.Y. State Department of Health
   - U.S. Army Corp of Engineers
   N.Y.C. Water and Sewer Department

   Noxious Pollutants in Air - N.Y.C. Department of Air Resources
   - Citizens For Clean Air

   Housing (Abandoned, Fire gutted, Hazardous)-Health Department
   - Housing and Development Administration
   - Metropolitan Council on Housing

   Wastes, Rubbish & Abandoned Cars -Sanitation Department
   - Citizens Committee to Kept NY Clean
   -Health Department

Parks and Recreation Areas - Parks, Recreation & Cultural Affairs Administration of New York City
- City Planning Commission
- Parks Council
- National Parks Services (New York City)

Noise - Trade Division of Department of Licenses
- Bureau of Noise Abatement
- Building Department

10. Encourage pupils to work together in preparing land-use maps, designs and drawings showing how areas could be improved. Ideas and designs for small recreational parks (converted empty lots) and new construction could be submitted to the Community Corporations and City Planning Commission.

Stimulate pupils' imagination by planning a trip to the midtown area so that pupils may observe building innovations (plaza, raised towers and small parks).

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FOR THE CLASS OR SCHOOL LIBRARY

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Mini-Climates
Birds
Pollution
Running Water
Snow and Ice
Trees
Astronomy
The Dandelion
Ecology
Mapping Small Places
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Your Senses

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Ecology-The Mountains and Man
Ecology-The Suburbs
Ecology-The Farm
Ecology-The Oceans and Man
Ecology-The Forests and Man
Ecology-The City
Ecology-The Freshwaters and Man
Ecology-The Grasslands and Man
Ecology-The Deserts and Man

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Plant Functions - Brown, Douglas G.
Insects - Collins, Barbara V.
Fish - Braker, William P.
Birds - Ohmart, Edna and Otto
Amphibians and Reptiles - Otto, George R.
Mammals - Ruffer, David G.
Human Body - Collins, Barbara J.
Air - Brewer, A.C.; Garland, Nell.
Oceanography - Dean, Anabel.
Water - Fellger, Merrill C.
Rocks and Minerals - Robinson, Roger E.
Weather and Climate - Hall, James P.
Our Changing Earth - Hungerford, Harold; Knapp,Clifford
Our Solar System - Posin, Dan G.
Beyond the Solar System - Collins, Lorence G.
Sound - Victor, Edward

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AUDIO-VISUAL AIDS

FILMSTRIPS

The World's Exhaust - Air Pollution (w/record)	ACAD. 52-1011
Our Troubled Waters - Water Pollution (w/record)	ACAD. 52-1012
The Unseen Enemy - Noise (w/record)	ACAD. 52-1013
The Wounded Land - Trash (w/record)	ACAD. 52-1014
Pesticides - (w/record)	ACAD. 52-1015
How Many Are Too Many? Over-population (w/record)	ACAD. 52-1017
Principles of Ecology (w/record)	ACAD. 52-1018
Environmental Recisions - An Inquiry (5 filmstrips) Forests, Wildlife, Water, Air, Soil	BFA
Discovering Your Senses - (6 filmstrips) Eyes, Ears, Skin, Tongue, Nose, Working Together	COR. S-172
Investigating Vertebrates - (6 filmstrips) What They Are: Fish, Amphibians, Reptiles, Birds, Mammals	COR. S-146
Ecological Communities - (6 filmstrips) Forest, Ponds and Lakes, Stream, Meadow, Thicket, Coniferous Forest	COR. S-205
Oceanography - (6 filmstrips) Waves, Tides, Ocean Current, Ocean Floor, Marine Sediment, Marine Life	COR. S-182
Pollution - (6 filmstrips) What Is It? Our Air, Our Waters, Solid Wastes, Pesticides and Radioactive Wastes, What We Can Do	COR. S-198
Water and How We Use It - (6 filmstrips) Power, Irrigation, Drinking, etc.	COR. S-190
Maintaining Biological Specimens	ENCY. BRIT. 11590
Plant and Animal Relationships	ENCY. BRIT. 10790
Prehistoric Life (set of 6)	ENCY. BRIT. 7500
Plants - How They Live and Grow (set of 6)	ENCY. BRIT. 9390
The Arctic Wilderness (set of 6)	ENCY. BRIT. 8550
The Living Desert (set of 6)	ENCY. BRIT. 8280
Adaptation (set of 4)	ENCY. BRIT. 11160
Plant and Animal Relationships (set of 6)	ENCY. BRIT. 10790
The Vanishing Prairie (set of 6)	ENCY. BRIT. 8400
The Earth and Its Wonders - Rivers, Water, Air, Mountains, Glaciers, Volcanoes (set of 6)	ENCY. BRIT. 7480
Infectious Diseases - Causes and Defenses (set of 4)	ENCY. BRIT. 11550
Don't Stand There - Do Something--Air, Water and Land Pollution (set of 4)	EYE-G. 11350
Interdependence of Nature - Cycles & Balance (set of 4)	EYE-G. M140
Introduction to Ecology-Ecosystems & Succession (set of 6)	EYE-G X46
Urban Ecology-Yard, Lot, Park, Pond (set of 6)	EYE-G. X77
Ecological Inbalance - 6 systems	EYE-G. X76
Why Animals Live Where They Live (set of 6)	EYE-G. X235
Fundamental Elements of Weather (set of 10)	EYE-G. 101

Man In His Environment Gp. 1--(2 filmstrips)	IMP. 520-1,2
Man In His Environment Gp. 2--(2 filmstrips)	IMP. 652-1,2
Ecological Systems Gp. 1--(4 filmstrips)	
Seashore, Pond, Forest, Desert	IMP. 434-1,2,3,4
The Underwater Environment Gp. 1--(4 filmstrips and records)	
Spiny Animals, Fish In Their Environment, Shellfish and Tubeworms	IMP. 447-1,2,3,4
The Underwater Environment Gp. 2--(2 filmstrips and records)	
Marine Vegetation	IMP. 448-1,2
Life Cycle of Common Animals Gp. 1	IMP. 441-1,2,3,4
Plants and Their Environment--(4 filmstrips)	
How Flowers Transfer Pollen	IMP. 443-1
How Plants Use Leaves	IMP. 443-2
How Seeds and Fruits Travel	IMP. 443-3
How Plants Use Other Plants	IMP. 443-4
Exploring the Animal World (4 filmstrips)	
Farm Animals, Animal Babies, Animal Differences, Tame Animals	IMP. 422-(1-4)
Basic Weather Series - Wind	SVE. 421-1
Weather Change	SVE. 421-2
Seasons	SVE. 421-3
Rain, Snow, Hail	SVE. 421-4
Understanding Weather and Climate Series - (Set of 6 plus 3 records), Air Masses & Fronts, Forecasting, Winds, Humidity, Moisture & Precipitation, Weather Changes	SVE. 404-SR
The Microscope and Its Uses-(4 filmstrips)	SVE. 448-S
Exploring The World of Nature-(set of 6), Part 1	SVE. 423-SA
Exploring The World of Nature-(set of 6), Part 2	SVE. 423-SB
Young Scientists Investigate Pollution-(4 strips plus 2 records) Smog, Air Pollution, Water	SVE. 428-SAR
The Ecological Crisis-(set of 6 plus 3 records) - Includes Population, Ecological Considerations, Evolution and Extinction, Pesticides, Pollution	SVE. C797-SAR
Surviving the Ecology Crisis - (set of 4 plus 2 records)	SVE. F200-SAR
Biology: Environment & Survival (4 filmstrips & 2 records)	SVE. E469-SAR
Oceanography (6 filmstrips and 3 records)	SVE. E503-SR
Introduction to Earth & Sun - (3 filmstrips and 2 records)	SVE. E410-SR
Conservation - (Soil, Forest, Water, Wildlife, Mineral, Urban, Land) (7 filmstrips and 4 records)	SVE. E433-SR
Our Ever Changing Earth (set of 6)	SVE. 443-S
Interdependence of Nature Series	
Cycle of Nature	UNIV 1401
Balance of Nature	UNIV 1402
Four Seasons	UNIV 1403
Conservation	UNIV 1404
Environmental Pollution--Our World in Crisis (6 filmstrips)	WARDS 70 W 3800
Man In The Biosphere--Human Ecology Series (6 filmstrips)	WARDS 70 W 4100
Man's Impact On His Environment (set of 9)	WARDS 168W 9000

FILM LOOPS

Erosion	BFA
Weathering	BFA
Soil Part 1 and 2	BFA
Humus	BFA
Structure of the Earth	BFA
Changing Continents	BFA
Ocean Bottoms	BFA
Dome and Volcanic Mountains	BFA
Lava Flows	BFA
Geysers	BFA
Glacial Movement	BFA
Life Through the Ages	BFA
Earthquakes	BFA
Birth of an Island	BFA
Water Cycle on the Oceans	BFA
Water Cycle on Land	BFA
Movement of Groundwater	BFA
Tropism Experiments (1 and 2)	BFA
Using A Microscope	BFA
Setting Up and Observing a Hay Infusion	BFA
Ecology and Environmental Studies	SVE
ECF 9071 Biosphere	SVE
ECF 9077 Man & Living Things	SVE
ECF 9078 Man, Technology, and Pollution	SVE
ECF 9079 Population	SVE
Paramecium	EYE G. 8101
Euglena	EYE G. 8102
Amoeba	EYE G. 8103
Stento	EYE G. 8106
Rotifer	EYE G. 8107
The Five Senses - set of 6 filmloops	EYE G. 821
Small Things - (color) - 11 filmloops, Microscopic organisms	SK 72943-20Q
Adaptation to the Environment (set of 4)	EAL. 89-1622/1

FILMS

Altered Environments: An Inquiry Into American Wildland-Color 10 minutes		BFA
Altered Environments: An Inquiry Into the Growth of Cities-Color 10 minutes		BFA
Adaptation to Ocean Environment	Color 11 Minutes	BFA
Water Pollution	Color 8 Minutes	BFA
Air Pollution	Color 8 Minutes	BFA
The City Changes	Color 14 Minutes	BFA
Recycling	Color 10 Minutes	BFA
Urban Ecology: Garbage	Color 7 1/2 Minutes	BFA
Noise	Color 10 Minutes	BFA
Which Is My World	Color 9 1/2 Minutes	BFA
Man's Effect on the Environment	Color 13 1/2 Minutes	BFA
Environment	Color 28 1/2 Minutes	BFA

Bulldozed America - 25 Min., B/W. Bulldozer and commercial interests tear apart countryside and turn it into supermarkets, highways, etc. CAR
The Poisoned Air - 60 Min. B/W. CAR

A Matter of Time - 27 min., color. Historical approach to environmental deterioration. CON. FOUN.

Our Crowded Environment - 11 min., color. ENCY. BRIT.
Population Ecology - 28 min., B/W. Ecological consequences if population is not brought under control. ENCY. BRIT.
Air Pollution - 15 min., color. Health problems posed by air pollution and steps being taken to correct them. ENCY. BRIT.
Water Pollution - 15 min., color. Health problems posed by water pollution and steps being taken to correct them. ENCY. BRIT.

A day at the Dump - 15 min., color. Free. Story of a dump in Washington, D.C. and its planned conversion to a public park. ECA
The Third Pollution - 30 min., color. Free. Graphially describes America's $4 billion solid waste problem and demonstrates new techniques of solid waste management. ECA

Clean Waters - 20 min., color. Order #3972. Illustrates dangers of water pollution and some methods of eliminating it. EXT. MED.
Noise: New Pollutant - 30 min., B/W. Order #7503. EXT. MED.

The Squeeze - 10 min., B/W. Throngs of people, jammed highways, rushing commuters, starving children graphically portray population problem HANK NEW.

The Prairie - color, 18 min. IFB
Life in the Deciduous Forest - color, 19 min. IFB
The Pond - color, 20 min. IFB
Adaptations for Survival: Birds - color, 14 min. IFB
Prairie Giant - color, 35 min. IFB

Man and His Resources - 28 min. B/W McG. Hill

By Land, Sea and Air - 31 min., color. Effects of pesticides on farm workers and environment of California O.C.A.W.I.U.

Beargrass Creek - 19 min., color. The tragedy of a small stream, its start and its sad end due to pollution. SF

STUDY PRINTS

Adaptation to Water Environment Series - Protection	BFA 224000
Adaptation to Water Environment Series - Movement	BFA 226000
Adaptation to Water Environment Series - Community Life	BFA 225000
Discovering Out Environment -(4 sets of 10 each)	COR F130
Set 1 What is An Environment	
Set 2 Living Things Use the Environment	
Set 3 Man Misuses the Environment	
Set 4 Restoring and Conserving the Environment	
Insects Harmful to Man	ENCY. BRIT.5650
How Animals Move	PYRAMID 4001
How Animals Get Food	PYRAMID 4002
How Animals Protect Themselves	PYRAMID 4003
How Animals Find Shelter	PYRAMID 4004
A Pond Community	PYRAMID 4006
Understanding Your Environment (Pictures that Teach Series)	SIL. BUR. 45240

VENDORS
FILMS, FILMSTRIPS, FILMLOOPS

ACAD.	Academic Paperbacks Saw Mill Road West Haven, Conn. 06516
BFA	BFA Educational Media 2211 Michigan Ave. Santa Monica, Calif. 90404
CAR	Carousel Films, Inc. 1501 Broadway New York, N.Y. 10036
CON.FOUN.	Conservation Foundation 1250 Connecticut Ave., N.W. Washington, D.C. 20036
COR	Coronet Instruc. Materials 65 East South Water St. Chicago, Ill. 60601
ENCY. BRIT.	Encyclopedia Britannica Education Corporation 425 North Michigan Ave. Chicago, Ill. 60611
ECA	Environmental Control Adm. 12720 Twinbrook Parkway Rockville, Maryland 20852
EXT. MED.	Extension Media Center University of California Berkeley, Calif. 94720
EYE-G.	Eye-gate House, Inc. 146 Archer Avenue Jamaica, N.Y. 11435
HANK NEW.	Bank Newenhouse 1825 Willow Rd. Northfield, Ill. 60093
IFB	International Film Bureau 332 S. Michigan Ave. Chicago, Ill. 60604
IMP	Imperial Film Co. Educational Development Corp. P.O. 1007 Lakeland, Fla. 33802
McG. Hill	McGraw Hill 330 West 42 St. New York, N.Y. 10036
O.C.A.W.I.U.	Oil, Chemical & Atomic Workers Int'l. Union 1126 16th St., N.W. Washington, D.C. 20036
PYRAMID	Pyramid Films Box 1048 Santa Monica, Cal. 90406
SIL. BUR.	Silver Burdett Co. Morristown, N.J.
SF	Stuart Finley Prod. 3428 Mansfield Road. Falls Church, Va. 22041
SVE	Society for Visual Educ Inc. 1345 Diversey Parkway Chicago, Ill.
UNIV.	Universal Education & Visual Arts 221 Park Ave. So. New York, N.Y. 10003
WARD	Wards National Science Estab. P.O Box 1712 Rochester, N.Y.

BEST COPY AVAILABLE

Transparencies and Charts

In addition to the filmstrips, loops and films, each school should prepare or purchase overhead projector transparencies which dramatically reinforce the learning process. Commercially prepared transparencies may be obtained from any of the vendors listed for films and filmstrips.

Wherever possible, overlays should be prepared or obtained so as to provide a sequential development of the subject matter.

The topics listed below are useful also as a guide for the preparation or purchase of charts from the vendors listed on the Approved Science List of Vendors and Supplies. The following topics are suggested:

Weather Factors
Cloud Formations
Land and Sea Breezes
Weather Map
The Atmosphere
Fronts and Weather
The Water Cycle
Predicting the Weather
Nitrogen, Carbon dioxide & Oxygen Cycles
Solar System
The Sun as a Source of Energy
Solar Prominences
Faulting
Vulcanism, Volcanoes
Folding and Faulting
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